

**Responsiveness Summary
Addressing Public Comments
On the Draft Cleanup Action Plan
For
North Market Street Site
Spokane, Washington**

January 2000



The Washington Department of Ecology (Ecology) has completed the Draft Cleanup Action Plan (DCAP) for the North Market Street Site (Site). In the DCAP, Ecology selects the cleanup remedies to be implemented at the Site. The potentially liable person(s) (PLPs) for the North Market Street Site are the Tosco Refining Company (Tosco), Phillips Petroleum Company (Phillips), and Chevron Pipeline Company (Chevron). The DCAP was made available for review and public comment from November 12, 1999 through December 14, 1999. Phillips Petroleum Company, Avista Corporation, and the Spokane County Water Quality Advisory Committee submitted comments to Ecology during the 30-day comment period. The General Comment section responds to comments common to more than one letter and provides additional information on the project. Specific comments are identified below with a corresponding response.

GENERAL COMMENT

Ecology authored the DCAP to fulfill the requirements set forth in WAC 173-340-360 and present the selected remedies for the Site contamination. Upon completion, the DCAP was made available for a 30-day public review and comment period. Ecology evaluated the information generated during the Phase I and II Remedial Investigations (RI) for the Site as well as information provided in the Feasibility Study (FS). The FS prepared by the PLPs presented soil and groundwater remediation alternatives for the Site and selected a preferred alternative for each contaminated media. In the DCAP, Ecology selected different cleanup alternatives than those selected by the PLPs in the FS.

COMMENTS

Phillips Petroleum Company

1. *Ground-water Quality Trends – Review of ground-water data collected over the past 10 to 15 years indicates that ground-water quality in the vicinity of the North Market Street site has improved. Our analysis of available data is summarized in our Supplemental Soil Vapor and Ground-Water Quality report (October 1999) that updates the ground-water quality conditions through June 1999. A copy of this report was submitted to you in early November and should be listed in Section 1.3 (Administrative Documentation). In the DCAP, Section 1.3 does not list the document(s) that present the results of the post-1996 soil gas and ground-water monitoring. The overall improvement in ground-water quality should be further emphasized in the DCAP because it provides part of the basis for the proposed ground water cleanup actions.*

Ecology will add to Section 1.3 the documents that present the results of the post-1996 soil gas and groundwater monitoring. An improvement in groundwater quality has generally been observed since the initial groundwater sampling in the late 1980s and the free product observances that occurred during the low water elevations of 1994. These improvements, due to product redistribution and other attenuation processes, are not the standard by which further improvements to water quality will be measured. Improvements are to be based on measurable and timely

reductions in fuel chemicals that extend for a distance of over 5,000 feet in the uppermost portion of the aquifer. The groundwater quality improvement mentioned by Phillips is not discussed in detail since a majority of the distal monitoring wells were installed after 1995, which coincided with historically high water elevations that may have obscured actual groundwater quality trends. More importantly, a review of groundwater quality data in facility- and near-facility wells (NM-4, NM-11, NM-13, and TW-2) suggest that groundwater quality has not improved since 1993. In fact, contamination levels are approaching historic highs in these wells, particularly for benzene. While the more distal monitoring wells appear less affected at this time, Ecology is very concerned and has determined that sole reliance on natural attenuation will not return the aquifer to its most beneficial use as a drinking water source in a reasonable time frame.

2. ***Biodegradation of Petroleum Hydrocarbons*** – Soil gas and ground-water monitoring data provide ample evidence that petroleum hydrocarbons are degrading in both the vadose and saturated (ground water) zones beneath the site as outlined in the October 1999 report prepared by DOF (Dalton, Olmsted, & Fuglevand). That natural attenuation of petroleum hydrocarbons is occurring is the primary basis for incorporating bioventing and monitored natural attenuation into the proposed remedy. However, there is little discussion in the DCAP concerning the data that show natural attenuation is occurring. Some discussion of natural attenuation in the vadose and saturated zones should be included in the DCAP.

Ecology will provide additional discussion regarding the natural attenuation that is taking place in groundwater and the vadose zone. Bioventing has been incorporated into the proposed remedy since test data indicate that biodegrading bacteria are present in the vadose zone. While biodegradation is occurring in the vadose zone, it appears very limited and soil gas data indicate that attenuation has not contributed to an observed decline in contaminant gas within the soil vapor cloud. Therefore, providing oxygen to the soil mass via bioventing will enhance biodegradation that may be occurring on a limited basis or stimulate new biodegradation.

As with the vadose zone, Ecology agrees that natural attenuation is occurring in groundwater. The natural attenuation alone is not adequate to remove the contamination, but must be coupled with a tool such as air sparging to enhance degradation kinetics.

3. ***Air Sparging*** – As has been discussed with Ecology and is summarized in DOF's October 1999 update report, ground-water quality is improving by natural attenuation processes. The installation of an air-sparging system to remediate the smear zone will not result in any significant improvement of the natural processes. While we expect that dissolved concentrations will fluctuate with time, the available data indicate that concentrations of dissolved contaminants will continue to decrease with time without air sparging.

As an alternative, we strongly urge Ecology to consider allowing the staging of the remediation. The near surface soil and soil vapor remediation should be completed and monitoring should continue for a reasonable period (say for five years) to assess the impact of the completed work and natural processes that are already improving ground-water quality. Water quality "triggers" should be incorporated into the CAP and based on these

triggers and monitoring data, the need for air sparging could be determined. This would have the benefit of moving the remediation forward in a deliberate matter and reduce the potential for unnecessary costs. In fact, if such a sparging system is installed, criteria will need to be negotiated to determine when it can be shut down. It is not reasonable to require the installation of an air-sparging system without agreement upon reasonable closure criteria.

Natural attenuation is occurring in groundwater as evidenced by an oxygen depleted or anaerobic plume core and consumption of other electron donors such as sulfate and nitrate within this core. However, anaerobic degradation of hydrocarbons is rate limited in comparison to aerobic degradation. Given the inadequate contamination attenuation rates in the anaerobic zone, and static contaminant concentrations adjacent to the plume core, Ecology has concluded that enhanced natural attenuation technologies are necessary in the vadose and saturated zones. Ecology believes that dilution and dispersion is contributing equally if not more than natural attenuation to a reduction in contaminant concentrations. As Ecology has stated in numerous correspondence, reliance on dilution and dispersion is not acceptable [(WAC 173-340-360 (5)(e)(iii))], particularly if active remedial measures are technically possible.

Ecology will not entertain staging the remediation as urged particularly when it involves the groundwater remediation. The implementation of air sparging technology will improve the aerobic microbial metabolism of the petroleum hydrocarbons, and reduce the elevated metals concentrations that have resulted from the anaerobic groundwater conditions. The sparging system will also provide a barrier to contain persistent mobile organic chemicals traveling within the plume path. Ecology agrees that performance criteria will need to be established for the sparge system operation. Ecology anticipated the performance criteria would be discussed during negotiations for the cleanup implementation.

4. ***Comment on Soil Cleanup Levels – Petroleum Hydrocarbons.*** *As indicated in the DCAP, the proposed soil cleanup levels for TPH related substances were set using the Interim TPH Policy method. This method sets cleanup levels that are protective of two exposure pathways including soil ingestion and ingestion of groundwater. Our review of data with the DCAP and our own analyses indicate that lower soil cleanup levels are derived using the Interim TPH Policy levels based on protection of ground-water quality as compared to those set solely for soil ingestion.*

A higher TPH soil cleanup level (10,000 mg/kg) than that proposed in the DCAP is justified by the available data as summarized below:

- *As outlined in our December 14, 1998 Technical Memorandum titled "TPH Soil Cleanup Levels – North Market Street Site, Spokane, WA", site data indicate that a TPH cleanup level of approximately 12,000 mg/kg to 15,000 mg/kg is protective of the soil ingestion pathway assuming a commercial land use.*

- *During our field work we observed well defined boundaries between contaminated (oily) soil and non-contaminated (non-oily) soil. Much of the soil remediation will be based on visual observation; i.e. oily soil will be remediated. In most instances, oily soils will exceed a cleanup level of 10,000 mg/kg. Confirmation sampling of non-oily soil will be completed which, based on available data*

A TPH cleanup level is also protective of ground-water quality. Soil immediately below the target oil soils meet the proposed DCAP level of 6,000 mg/kg and in most cases, TPH is not detected. In addition, the impact of any leaching of TPH constituents is mitigated by the separation (over 100 feet) between the near surface oily materials and the water table where available data indicate that natural biodegradation is occurring.

It is not appropriate to apply the Interim Policy guidance to set soil cleanup levels at the North Market Street site because the method assumes, among other conditions, the following:

- *Soil contamination extends from the surface to the water table;*
- *Contaminants are uniformly distributed throughout the zone of contamination;*
- *There is no chemical or biological degradation in the unsaturated zone.*

These conditions are not seen at the site. Extensive soil sampling beneath areas of the site containing oily soil indicates that soil contamination does not extend to the water table and is not uniformly distributed from the ground surface to the water table. In addition, as describe in the RI and the October 1999 supplemental update report, there is evidence that degradation of petroleum hydrocarbons is occurring in the unsaturated zone.

As mentioned, Ecology utilized the Interim TPH policy to help derive cleanup levels for the North Market Street Site. Application of the Interim TPH Policy to establish cleanup levels at the North Market Street Site is appropriate. The regulated community encouraged Ecology to provide cleanup levels, other than Method A, for TPH. Because of the absence of adequate toxicity data regarding all constituents of petroleum mixtures, Ecology established the Interim Policy, using an accepted surrogate approach, which provides for the calculation of Method B/C TPH cleanup levels. These cleanup levels must assure protection from direct exposure and migration from soil to groundwater. For the protection of groundwater a fate and transport approach is appropriate and must be conservative to assure that concentrations of TPH remaining in the soil do not further contribute to groundwater contamination. The equilibrium partitioning and mass balance mixing model used incorporates common simplifying assumptions due to the uncertainties inherent in complex petroleum mixtures, contaminant soil physics, and hydrogeologic systems. The fate and transport of contaminants in the North Market Street Site is complex and the magnitude of contamination is very large. As such, the simplifying assumptions used in the policy may be conservative, but are reasonable. Further, Phillips' comment requests that Ecology elevate TPH cleanup levels to almost double the current cleanup level. It is unclear to Ecology how Phillips can support the use of the TPH Policy as being protective, but rejects the cleanup level yielded by the same policy.

Point of Compliance Monitor Wells

The last paragraph of Section 7.3 Point of Compliance states that monitoring wells NM-11 and TW-2 will be used to assess water quality conditions at the point of compliance. We suggest that language be added to provide for some flexibility to move or replace wells to monitor the point of compliance. For example, we do not believe that well TW-2 is necessarily constructed properly to function as a long-term monitor well and may need to be replaced.

Monitoring wells NM-11 and TW-2 were selected to assess water quality at the point of compliance since these wells are located near the facility boundary. Ecology will be flexible in agreeing to the addition or replacement of monitoring wells to assess groundwater at the point of compliance as long as the wells are located within the plume at the facility boundary.

Cleanup Action Plan – Area 3

Section 7.1 Soil Cleanup implies that most (all) of the contaminated soil from Area 3 (Tank 491) can be excavated (fifth paragraph). We suggest the text be refined to indicate that some of the contaminated soil can be excavated, to be consistent with the last sentence of the paragraph.

Ecology does not see the necessity to change the text. During the design phase, a setback from Tank 491 can be determined and then field observations will determine the amount of soil removed in cleanup.

Institutional Controls

Section 7.4 of the DCAP proposes that in certain circumstances institutional controls on real property or property rights be established, and this may include a restriction upon the use of ground water beyond the property controlled by any of the PLPs. The PLPs are concerned that this may not be within their power to accomplish, even using reasonable measures available to them. If the situation arises where the PLPs cannot obtain the necessary restrictions, using reasonable measures, then Ecology and other State and local governments will need to lend their support to meet this DCAP requirement.

It is the PLPs' responsibility to obtain institutional controls on properties not owned by the PLPs that have been affected by contaminants from the Site. At this time, Ecology is not aware of any efforts on behalf of the PLPs to begin communication with the affected landowners. Ecology has suggested on several occasions that the PLPs begin dialogue with these landowners regarding institutional controls. We can assist with obtaining access to properties pursuant to WAC 173-340-800.

Spokane County Water Quality Advisory Committee

...the Water Quality Advisory Committee of Spokane County would like to recommend that the Washington State Department of Ecology pursue their recommended Draft Cleanup Action for the North Market Street Site as soon as feasibly possible.

The oil and fuel spills at this site have been present for much too long and any delay in the cleanup has potential to further contaminate the Spokane Aquifer present at the site of the cleanup.

Ecology will continue to pursue an expeditious cleanup at the North Market Street Site.

Avista Corporation

Without having more detailed information relative Ecology's proposed cleanup affecting Avista property, it is difficult for us to be as specific in our comments as we would like. However, the proposed action at minimum appears to suggest the following issues, which need to be addressed as part of Ecology's Cleanup Action Plan:

- 1) *Restrictions on groundwater use;*

Ecology will add this language to the Cleanup Action Plan. Institutional controls will be required that restrict or limit groundwater extraction and use near the plume boundaries. If groundwater use is proposed near the plume, a demonstration must be provided for Ecology's review that shows the groundwater plume will not be affected by the usage.

- 2) *Restrictions and/or interference with the use of Avista property in the future;*

At this time, the proposed location for the air sparging system is on Avista property. The general location is between monitoring wells NM-18 and NM-22, east of NM-20 with a configuration perpendicular to the plume.

- 3) *Issues of access to Avista property both with respect to the immediate construction activities that might occur on Avista property as well as future site monitoring access issues;*

Avista and the PLPs will need to enter into agreements for access to Avista property. This will include the long-term monitoring as well as any construction activities that will be required as part of the cleanup.

Actual location of point of compliance and cleanup levels to be determined; and

The point of compliance will be the Tosco facility boundary. The cleanup levels are established in the DCAP.

4) *Future institutional controls, if any, that may result from the proposed Cleanup Action Plan.*

As stated in the response to Avista Comment #1, institutional controls will be required on property overlying the groundwater plume. Institutional controls will be required in areas that soil contamination which exceeds cleanup levels remains in place.

DRAFT CLEANUP ACTION PLAN

1.0 INTRODUCTION

The North Market Street Site (Site) is the subject of this Draft Cleanup Action Plan (DCAP). The cleanup actions selected for the Site are based upon information contained in the Washington Department of Ecology's (Ecology) files, information presented in remedial investigations (RIs) and the feasibility study (FS) completed by the potentially liable person(s) (PLPs). The North Market Street Group (Group), which is comprised of Phillips Petroleum Company (Phillips), Tosco Refining Company (Tosco), and Chevron Pipe Line Company (Chevron) are PLPs for the Site.

Ecology is responsible for the cleanup action selection and the completion of the DCAP. The selected cleanup action is intended to fulfill the requirements of the Model Toxics Control Act (MTCA) RCW 70.105D. More specifically, the objectives of this document are to satisfy the MTCA requirements set forth in WAC 173-340-360(10) and will include the following:

- A brief Site history description;
- A description of the nature and extent of Site contamination summarized from the remedial investigation (RI);
- Establishment of cleanup standards for each contaminated media that are protective of human health and the environment;
- Presentation of proposed remedial alternatives summarized from the feasibility study (FS); and
- Ecology's selected cleanup action.

1.1 Site Location

The Site is defined as the area of soil contamination and the groundwater contaminant plume. This definition includes the fuel terminal currently operated by Tosco (Facility) and the groundwater plume where contaminants above background levels have been detected. The Site is bounded by Lincoln Road on the south and Freya Street to the east. A private roadway on the Kaiser south property borders the Site to the north. The western boundary roughly parallels North Market Street. (Figure 1). The North Market Street Site is located mostly in Section 22 and a portion of Section 21, Township 26 North, Range 43 East, Willamette Meridian in Spokane County, Washington. The Site is located approximately one mile north of the City of Spokane corporate limits.

1.2 Applicability

This DCAP is applicable only to the North Market Street Site. The remedial actions to be taken at this Site were developed to meet the threshold requirements and other requirements of WAC 173-340-360. Cleanup levels have been developed and cleanup actions selected as an overall remediation process being conducted under Ecology oversight using MTCA authority, and should not be considered as setting precedents for other sites.

1.3 Administrative Documentation

Documents used to develop this DCAP and the decisions contained herein are contained in Ecology's files. The administrative record for this Site is on file and available for public review by appointment at Ecology's Eastern Regional Office, located at 4601 N. Monroe, Spokane, Washington 99205-1295. Documents that were made available for public comment are also available at the Spokane Public Library – Hillyard Branch. The following documents were used to develop the proposed cleanup action:

- **Dalton, Olmsted, & Fuglevand, Inc., 1993a, Interim Remedial Investigation Report, North Market Street Site, Spokane, Washington.** Report prepared for Burlington Northern Railroad Company, Chevron Pipe Line Company, Phillips Petroleum Company, and Tosco Refining Company; January 1993.
- **Dalton, Olmsted, & Fuglevand, Inc., 1993b, Work Plan, Remedial Investigation/Feasibility Study, North Market Street Site, Spokane, Washington.** Report prepared for Burlington Northern Railroad Company, Chevron Pipe Line Company, Phillips Petroleum Company, and Tosco Refining Company; March 1993.
- **Dalton, Olmsted, & Fuglevand, Inc., 1994, Results of November 1993 Groundwater Sampling, North Market Street Site, Spokane, Washington.** Report prepared for Burlington Northern Railroad Company, Chevron Pipe Line Company, Phillips Petroleum Company, and Tosco Refining Company; March 1994.
- **Dalton, Olmsted, & Fuglevand, Inc., 1995a, Cleanup Levels Analysis/Risk Assessment, North Market Street Site, Spokane, Washington.** Report prepared for Chevron Pipe Line Company, Phillips Petroleum Company, and Tosco Company; September 1995.
- **Dalton, Olmsted, & Fuglevand, Inc., 1995b, Results of November 1994 Groundwater Sampling, North Market Street Site, Spokane, Washington.** Report prepared for Chevron Pipe Line Company, Phillips Petroleum Company, and Tosco Refining Company; September 1995.
- **Dalton, Olmsted, & Fuglevand, Inc., 1996, Final Draft Remedial Investigation Report, North Market Street Site, Spokane, Washington.** Report prepared for Chevron Pipe Line Company, Phillips Petroleum Company, and Tosco Refining Company; June 1996
- **Dalton, Olmsted, & Fuglevand, Inc. and Remediation Technologies Inc., 1998, Feasibility Study: North Market Street Site Remediation, Spokane, Washington.** Report prepared for Chevron Pipe Line Company, Phillips Petroleum Company, and Tosco Refining Company; June 1998
- **Dalton, Olmsted, & Fuglevand, Inc., 1998, Technical Memorandum TPH Soil Cleanup Levels: North Market Street Site Remediation, Spokane, Washington.** Report prepared for Phillips Petroleum Company; December 1998
- **Dalton, Olmsted, & Fuglevand, Inc. and Remediation Technologies Inc., 1999, Technical Memorandum Treatability Study: North Market Street Site Remediation, Spokane, Washington.** Report prepared for Phillips Petroleum Company; January 1999
- **Dalton, Olmsted, & Fuglevand, Inc., 1999, Supplemental Ground-Water and Soil Vapor Quality Monitoring Report: North Market Street Site, Spokane,**

- Washington. Report prepared for Phillips Petroleum Company; November 1999
- Ecology and Environment, 1989, Technical Assistance Team Site Assessment Final Report for Tosco Corporation Spokane Terminal, Spokane County; TDD T10-8810-013. Prepared for U.S. Environmental Protection Agency.
 - EMCON, 1993a, Memorandum to Paul Beveridge from Steve Sagstad, Status Report – Monitoring Well Installation and Groundwater Sampling at the North Market Street Site, July 17, 1993
 - EMCON, 1993b, Status Report – Tank 302 and Transmix Spill Response Activities July 13, 1993. Prepared for Tosco Spokane Terminal.
 - EMCON, 1993c, Operational Report, April 6, 1993 to July 1, 1993 Vapor Extraction System/TOSCO. September 28, 1993.
 - EMCON, 1993d, Vapor Extraction System Activity Status Report, TOSCO Terminal, Spokane, Washington. October 28, 1993.
 - EMCON, 1993e, Operational Report, July 1, 1993 to October 1, 1993 Vapor Extraction System/TOSCO. September 28, 1993.
 - EMCON, 1995, Operational Report, December 31, 1994 to March 31, 1995 Vapor Extraction System/TOSCO. April 10, 1995.
 - Golder Associates, 1985, Phase I Remedial Investigation for the North Market Street Site. Volumes I, II, and III. Report prepared for Ecology.
 - Golder Associates, 1988, Data Compilation Report for the North Market Street Site, Phases I, II, and III Remedial Investigations. Report prepared for Ecology.
 - Golder Associates, 1990, Environmental Report Tracking System, Spill Report, Tosco Refining Company, East 3225 Lincoln Road, Spokane, Washington.
 - Sweet-Edwards/EMCON, Inc., 1991, Draft – Status Report – Monitoring Well Installation and Groundwater Sampling at the North Market Street Site.

1.4 Cleanup Process

Cleanup conducted under the MTCA process requires specific documents to be submitted to Ecology. These documents are used by Ecology to determine the remedial actions to be conducted and the monitoring requirements prior to and following a cleanup action. These procedural tasks and resulting documents along with the MTCA section that requires their completion are listed below with a brief description of each task.

- Remedial Investigation and Feasibility Study - WAC 173-340-350
- Draft Cleanup Action Plan - WAC 173-340-360
- Engineering Design Report - WAC 173-340-400
- Construction Plans and Specifications - WAC 173-340-400
- Operation and Maintenance Plan - WAC 173-340-400
- Cleanup Action Report - WAC 173-340-400
- Compliance Monitoring Plan - WAC 173-340-410
- Public Participation Plan - WAC 173-340-600

The Remedial Investigation and Feasibility Study (RI/FS) process documents the investigations and engineering evaluations conducted at the Site from the discovery phase

to the final RI/FS. The investigations are designed to characterize the type and extent of contamination and the associated risks posed by the contamination to human health and the environment. The FS presents and evaluates different Site cleanup alternatives and proposes the preferred cleanup alternative.

The DCAP sets the cleanup levels and standards for the Site and selects the cleanup actions intended to achieve the cleanup levels. After opportunity for public comment, the DCAP becomes final.

The Engineering Design Report outlines the engineered system and design components of the DCAP. Construction Plans and Specifications provide the technical drawings and specifications for design and implementation of the DCAP.

The Operation and Maintenance (O&M) Plan summarizes the requirements for inspection and maintenance as well as the regulatory and technical necessities to assure effective operations. The O&M Plan outlines the actions inherent to operate and maintain any equipment, structures, or other remedial facilities used in the cleanup action.

A Cleanup Action Report will be completed following implementation of the selected remedial action. The report will detail the activities performed for the Site cleanup and provide documentation of adherence to or variance from the DCAP.

Compliance Monitoring Plans are designed to serve the following three purposes:

- Protection – Confirm that human health and the environment are being protected during construction and Operation & Maintenance (O&M) phase of a cleanup action.
- Performance – Confirm that the cleanup action has attained cleanup standards.
- Confirmation – Confirm the long-term effectiveness of the cleanup action after cleanup standards have been attained.

The Public Participation Plan is the framework to provide the public with information and give them the opportunity for participation in a site. The plan is tailored to meet the public's needs and coordinate their effort in the MTCA process.

2.0 SITE HISTORY

The following sections discuss the ownership, operational, and regulatory history of the North Market Street Site. The information provided herein was provided in the Remedial Investigation report completed by Dalton, Olmsted & Fuglevand and other reports provided to Ecology.

2.1 Ownership History

Several of the properties that comprise the North Market Street Site were developed as industrial or commercial facilities that were involved in or related to the refinement, recycling, and sale of petroleum products. This section is not the result of a title search

and is based upon information gathered from various sources. The Montana Headlight Oil Company occupied the southwest portion of the North Market Street Site as shown on Figure 2. Aerial photographs show the refinery was in existence in 1938. Inland Empire Refineries, Inc acquired the Montana Headlight refinery at an unknown date. Inland Empire Refineries, Inc. was later acquired by the Wasatch Oil Company, which was later acquired by Phillips Petroleum Company. The former location of the refinery, associated storage tanks, and water supply wells cover the property currently occupied by A-Z Rentals and Clark & Sons Landscaping. The A-Z Rentals property is now known as Rent-X.

In addition to the Montana Headlight refinery on-site, the Inland Empire Refinery was reportedly constructed in 1938 and began operations in 1939. The crude oil for refining was supplied by rail. As shown on Figure 2, the Inland Empire Refinery was located in the south-central portion of the Site. The refinery was sold to Wasatch Oil Company of Utah in about 1945. By the late 1940s the refinery complex had an estimated daily output of approximately 314,832 gallons of refined petroleum products.

Wasatch Oil Company operated the refinery until about 1948, when it was sold to Phillips Petroleum Company. Land ownership information indicates that the Wasatch Oil Company owned the property currently owned by Draper, Chevron Pipe Line Company, and Schmidt (Figure 2). In 1949, Wasatch Oil reportedly conveyed the properties to Phillips Petroleum. Sometime after 1949, the property currently owned by Draper was conveyed to Standard Oil. The ownership information contained in the Golder, 1985 report shows the Draper property was purchased from Standard Oil about 1978. This same information source indicates that the Schmidt property was purchased from Standard Oil but the date of conveyance is not given. Phillips Petroleum Company also sold the Montana Headlight Oil Company site to Shell Oil Company in 1958. Shell Oil Company sold the parcels making up the site to various individuals in 1967.

Phillips Petroleum Company operated the refinery until late 1953 when the refinery operations were discontinued and decommissioned. The facility was then purchased by Petroleum Terminal Company, a subsidiary of Phillips Petroleum, and converted into a distribution terminal. The Petroleum Terminal Company operated the distribution facility until 1976. The facility was sold to the Tosco Corporation and is currently operated by them as a tank farm and terminal facility.

Thirty tanks ranging from a two thousand-barrel capacity to fifty thousand-barrel capacity are currently located within the Tosco tank farm area. Earthen dikes, most of which are now protected from erosion by a gravel layer over their surface, surround the tanks. Dikes that are not so protected require periodic maintenance due to wind erosion. The storage tanks have an estimated cumulative capacity of approximately 391,500 barrels (bbl) or 16,443,000 gallons. The Chevron Pipe Line Company provides a majority of the product to the tank farm from its terminal located immediately north of the tank farm. Additional product and/or additives are received by rail and blended as needed.

2.2 Operational History

During refinery operations, liquid wastes containing organic compounds were discharged into a series of unlined oily waste ponds located in the northwestern portion of the property. These waste management practices were common during that era; however, it resulted in releases of liquid petroleum wastes into the environment. Based on historical aerial photographs, the approximate locations of the ponds are shown in Figure 3.

2.2.1 Refining Operations

The following is a brief description of refining operations that was contained in a 1949 Wasatch Oil Company report. The initial steps in the Wasatch Oil Company refining process were filtering, heating, and dewatering of the crude oil to remove "bottoms," solids, and wastes. Dewatering apparently occurred in a "water settler" tank. Water from the tank was drawn off while dewatered crude was used to begin the refining process. Dewatered crude was separated into "straight run gasoline" and "bottoms" in the Crude Prefractionator. "Bottoms" from the prefractionator were further distilled in the Crude Fractionator to produce gasoline, naphtha, stove oil, diesel fuel and "topped crude". A portion of the "topped crude" was further distilled under vacuum conditions to produce vacuum gas oils and asphalt. Remaining "topped crude" and domestic fuel was converted in the Visbreaking Furnace to a lower viscosity fuel oil. Vacuum gas oils from the Vacuum Furnace and fuel oils from the Visbreaking Furnace were further refined into gasoline, domestic fuel and fuel oil in the Gas Oil Cracking Unit. Several other processes operated at the refinery to upgrade products produced by the refinery. A more complete description of the processes employed at the Wasatch Oil Company Refinery can be found in the RI report.

2.2.2 Pipeline Operations

The main Chevron pipeline originates in Pasco, Washington, as part of the line from Salt Lake City. The Salt Lake to Pasco pipeline transports product that originates at refineries and pipeline terminals in the Salt Lake City area. At Pasco, fuels may originate from the Salt Lake pipeline segment, or come from the barge terminals in Pasco delivering product from refineries in Washington and California.

At the terminating point in Spokane, a manifold system allows transfer of petroleum between the Tosco Tanks, Yellowstone Pipeline Company's pipeline system in the Spokane area, the pipeline to a Conoco facility, or to a fuel line owned by Avista (formerly Washington Water Power). This product is metered prior to being transferred between companies. Chevron Pipe Line Company transports product only. It does not receive product from any of these systems. The Yellowstone Pipeline Company delivers approximately 20,000 to 30,000 bbl of product per month (approximately 300,000 bbl annually) to the Tosco Facility.

The Pasco to Spokane portion of the Chevron pipeline was constructed in 1954. The pipe on the North Market Street Site is 8-5/8 inch outside diameter seamless pipe, protected

with a somastic coating. The line is cathodically protected from corrosion. The Chevron pipeline is buried about 30 inches below grade throughout the Site.

2.2.3 Fuel Terminal Release Incidents

Although there are no records of specific releases from the refinery and tank farm prior to when laws and regulations were promulgated requiring release reports, it would be reasonable to assume that releases occurred during operations between the 1930s to the 1970s. The following list of incidents includes spills or releases for which documentation exists. These incidents are in addition to the historic releases resulting from refinery and fuel terminal operations. The approximate locations of spills, where known, are shown on Figure 2.

In May 1950, a report by the State Pollution Control Commission indicated that oily waste from the ponds on the Phillips Refinery property had ponded along the highway between the refinery and Mead. Notes from the State Pollution Control Commission indicate that the oily material was to be removed from the highway right of way in September of 1950. No follow-up information regarding the oily material removal was found.

Tosco personnel discovered a small "pit hole" leak in the bottom of leaded premium gasoline Tank No. 105 in 1978. There are no written records of the amount lost; however, the local operators remember it as a small leak. The tank bottom was repaired and a new fiberglass bottom installed in October of 1979.

In October 1979, a report to Ecology from Tosco indicated that approximately 709 barrels of Jet A fuel were spilled during an overfill of Tank 158 in the tank terminal. According to the report, the spill was within a diked area. When the spill was discovered, water was pumped into the spill area in an attempt to float the product and reduce further seepage. The Jet fuel was pumped to another tank (stove oil tank), and the water was then pumped to a containment area to be absorbed by dry sand and evaporation.

A report to Ecology from the Washington State Highway Patrol indicated a semi-trailer overturned in the ditch along the north side of Freya Street. The incident occurred in December 1979. The tank hatches opened and spilled approximately 7,000 gallons of diesel and gasoline. The spill report indicates that Ecology "considered excavating, but the area in question has had a great amount of oil spilled in the past (i.e. old refinery, railroad spills) and excavation would accomplish little good."

In about 1980, Tosco operators recall a small leak in a 6-inch pipeline in the middle of the tank farm, where the pipe was buried while resting on a wooden skid, which caused corrosion at the point of contact. There were no records of the leak found in the file or records of the amount of product lost, but it was considered small. The leak was promptly repaired.

In March 1985, a report to Ecology by Matlack Trucking indicated a 450-gallon spill of regular gasoline. The driver loaded his trailer at the Tosco terminal and noticed a hole in a truck tank drainpipe. The leak was draining into a containment area. The truck was moved to the truck turn-around area where gasoline spilled onto the ground surface. The amount that drained onto the ground was not indicated in the report. The Ecology report indicates that the gasoline "ran down the road about 150 feet."

On April 7, 1989, an initial telephone spill report was recorded by Ecology from Tosco Corporation. The report indicated that about 2,000 gallons of leaded gasoline were spilled in the Tosco terminal when a tank (Tank 302) roof drain broke. The amount leaked was actually about 1,000 barrels (or about 40,000 gallons). A report by EMCON (1993) describes the remedial measures taken to mitigate the effects of this release.

A transmix spill occurred at an unspecified time between December 8 and December 10, 1990, when a 2-inch pipe union located immediately north of the warehouse building and adjacent to the railroad spur broke. A report by EMCON (1993) describes spill and response measures.

2.2.4 Pipeline Incidents

Chevron Pipe Line Company has conducted three hydrostatic tests to determine the integrity of the Pasco to Spokane segment of the pipeline. The first two tests were conducted in 1974 and 1980. The hydrostatic tests were made by placing a tender of water between product shipments, then pressuring the pipeline to 90 percent of the yield pressure of the weakest pipe segment. Following these two tests, the test waters were separated from the product shipments at the Spokane terminal and were disposed of into an unlined impoundment where they percolated into the ground. A third test was performed in 1985. Test water from the 1985 test was taken to a sewage treatment plant. No leaks were detected and no repairs were necessary at the pipe line terminal based on the tests.

The hydrostatic test waters totaling about 2,000,000 gallons disposed of on-site were not analyzed for dissolved hydrocarbons. According to the Chevron memorandum, the hydrostatic test waters probably contained concentrations of dissolved hydrocarbons similar to hydrostatic test waters from the Chevron's El Paso-Albuquerque pipeline, with aromatic compounds (which include BTEX) reported to be less than 50 parts per million with phenol contents between 0.3 and 11 parts per million, and gasoline was reported to range from about 0.07 to 0.27 percent (700 to 2700 ppm).

One product spill has been recorded at the Chevron Pipe Line Company Spokane facility. In June 1981, about 25 barrels of diesel leaked from the buried pipeline near its entrance into the terminal. The contaminated soil is reported to have been removed and replaced with clean soil. The pipeline segment was bypassed and permanently taken out of service.

2.3 Regulatory History

As early as 1978 local land owners and businesses located north of the present day Tosco tank terminal reported the presence of petroleum-laden soils on lands immediately north of the decommissioned oil refinery complex. In 1978, Dale Draper purchased about nine acres of property from Standard Oil Company (Chevron). The property is located in the northwest corner of the original refinery property, as shown on Figure 2. A portion of the Draper property included an area containing some of the oily waste ponds. According to summary Site history notes in Ecology files, 1,000 cubic yards of oily soil were moved from the property by Draper and transported to Colbert Landfill.

In 1984 state officials confirmed the presence of petroleum contamination to groundwater from samples collected at three private water supply wells in the area. Use of those wells was discontinued and Ecology began supplying bottled water to users at that time. In 1991, the North Spokane Irrigation District No. 8 completed a 16-inch water line loop as far north as Magnesium Road to provide a potable water supply to users previously requiring alternate supplies.

Ecology, through a remedial contractor, Golder Associates, began remedial investigations at the Site in 1985. Golder Associates completed work for Ecology in 1988, which resulted in the completion of Phases I, II, and III Remedial Investigations.

The North Market Street Site was nominated for the Superfund National Priorities List (NPL) of hazardous waste sites requiring cleanup in 1988. In 1990 the U.S. Environmental Protection Agency (EPA) listed the North Market Street Site on the NPL. After the Site was listed, Ecology assumed the lead to direct cleanup under the authority of MTCA Chapter 70.105D RCW.

On February 25, 1991, Ecology issued proposed findings of potentially liable person status to Tosco, Chevron, Phillips, and Burlington Northern as owner and/or operator of the Facility under RCW 70.105D.040. On May 15, 1991, Ecology issued final determinations of PLP status to Tosco, Chevron, Phillips, and Burlington Northern as an owner and/or operator of the facility.

Ecology issued Agreed Orders to the PLPs to perform Phase I of the RI/FS at the facility. Burlington Northern Railroad Company (BN), Chevron Pipe Line Company (Chevron), Phillips Petroleum Company (Phillips), and Tosco Refining Company (Tosco) signed Agreed Orders to perform the Phase I work at the facility. Collectively these four PLPs, referred to as the "North Market Street Group", formed a work group and designated a project coordinator to implement the Phase I RI/FS Scope of Work (SOW)

In October 1994, Tosco, Chevron, and Phillips signed an Amendment to the Agreed Order. The Amendment to the Order provided for performance of a Phase II Remedial Investigation and Feasibility Study.

BN submitted a Work Plan to Ecology in October 1994 to conduct soil remediation at the BN property south of Lincoln Road. A De Minimis Consent Decree settlement was signed between Ecology and BN in February 1995. This settlement removed BN from the North Market Street Group.

The North Market Street Group, now consisting of Tosco, Chevron, and Phillips, completed the Phase II Remedial Investigation in June 1996. Supplemental RI work was conducted after finalization of the Phase II report to provide additional information on the size and characteristics of the groundwater contamination plume.

In June 1998, Ecology issued Enforcement Order No. DE 98TC-E103 to the North Market Street Group to complete additional groundwater and soil gas monitoring of monitoring points and treatability testing of smear zone soil samples.

The Feasibility Study (FS) was finalized in July 1998 after a 30-day public comment period. The FS did not include the information generated from the work completed under the Enforcement Order.

3.0 PHYSICAL SETTING

The North Market Street Site is located in the Hillyard area of Spokane, Washington approximately one mile north of the City of Spokane corporate boundary. Topographic map coverage of the Site and Site vicinity is provided by the Spokane Northeast Quadrangle, U.S. Geological Survey, 7.5 minute series dated 1973 and photorevised in 1986. The Site elevation is about 1,990 feet using the National Geodetic Vertical Datum (NGVD) of 1929.

The Site is located on the eastern side of a glacial outwash valley. The land surface slopes to the north-northwest at approximately one percent. Bedrock outcrops and associated highlands form the eastern boundary of the valley. The highlands rise to over 2,200 feet in elevation.

The nearest significant surface water body is Deadman Creek located approximately three miles north of the Site. The Spokane and Little Spokane Rivers are the major surface water courses in the area. The Spokane River lies approximately 3.5 to 4.0 miles south of the Site while the Little Spokane River lies approximately 4 miles northwest of the Site. Generally, both rivers flow in a westerly direction. Based on groundwater flow directions, the Spokane River is hydraulically upgradient of the Site while the Little Spokane River is downgradient of the Site.

3.1 Regional Hydrogeology

The North Market Street Site lies above the Hillyard Trough portion of the Spokane-Rathdrum Prairie Aquifer (Spokane Aquifer). The U.S. Environmental Protection Agency designated the aquifer as a "sole source aquifer" in 1978. This designation under provisions of the Federal Safe Drinking Water Act of 1974 recognizes the aquifer is the major source of drinking water for the Spokane area.

The Spokane Aquifer is within the Spokane Flood deposits. These deposits consist of glaciofluvial sands and gravels with cobbles and boulders and inclusions of silt and clay lenses that were deposited in a bedrock valley (Drost and Sietz, 1978). The deposits within the Hillyard Trough are finer grained than those found over much of the aquifer, being comprised predominantly of stratified sand with some gravel, silt and cobbles.

The aquifer extends westward from the Washington-Idaho state line to the east side of the City of Spokane and then turns northerly towards Long Lake. Five Mile Prairie splits the aquifer into two portions just northwest of Spokane. The aquifer boundaries in the Hillyard Trough are generally comprised of flow basalt or granitic intrusives.

In the vicinity of the Site and extending in an easterly to westerly direction, the aquifer ranges in thickness between 40 to 60 feet. The depth to groundwater is approximately 150 to 190 feet along this profile depending on ground surface elevation. Discharges of groundwater migrating through the trough occur from subsurface and spring flow into the Little Spokane River approximately four miles northwest of the Site. The discharge flow has been estimated by the USGS at 310 cubic feet per second (cfs) (Drost and Sietz, 1978) but actually may be about half this estimate (Spokane County, 1979).

3.2 Site Hydrogeology

Water level measurements in monitoring wells, which are screened in the regional aquifer, indicate the depth to the water table is approximately 155 to 160 feet below ground surface beneath the Site. Groundwater levels have been collected since 1987 as part of Site investigations. Contours of water table elevations within the Spokane Aquifer indicate that groundwater flows in a northwesterly direction in the Site vicinity.

Water level elevations are substantially higher in bedrock wells as compared to the aquifer wells. The higher water level elevations in the bedrock monitoring wells indicate groundwater flows from the bedrock areas to the regional aquifer. Localized groundwater flow directions vary from the expected northwesterly direction in the Spokane Aquifer in this area.

A horizontal hydraulic gradient of between 0.0029 feet/foot and 0.0077 feet/foot is estimated across the Site. Flow velocities are estimated to be 3 to 7.4 feet per day. Higher groundwater flow velocities have been estimated in other portions of the aquifer where gradients and hydraulic conductivities are higher.

3.3 Zoning

The zoning boundaries largely follow land use boundaries with few exceptions. Within 1.5 miles of the North Market Street Site, zoning includes Light Industrial (I-2) and Heavy Industrial (I-3), Business, Semi-residential Rural, Urban Residential, and Suburban Residential. Also included within the 1.5 mile radius are small areas zoned Mining. The North Market Street Site is within an area zoned as I-3 (Heavy Industrial). Permitted property uses within the I-3 zoning include heavy manufacturing and refining.

Mostly business and industrial land use mixed with residential is observed along Market Street.

4.0 REMEDIAL INVESTIGATION

The initial RI completed by Golder included excavation and sampling of 63 test pits. Eleven borings were drilled and six monitoring wells were installed on the North Market Street Site. Golder also performed a geophysical survey using ground-penetrating radar. Soil samples and water samples were submitted for volatile and semivolatile constituents. A limited set of samples was submitted for metals, polychlorinated biphenyls (PCBs), and pesticides.

The first phase (Phase I) of the Site RI was completed by the North Market Street Group's consultant in 1993. The investigative work resulted in: the installation of 10 groundwater monitoring wells; an assessment of groundwater and soil quality; an evaluation of hydrogeologic conditions; a preliminary evaluation of soil conditions above the water table; and an increased understanding of the extent and sources of groundwater contamination.

Results from the Phase I RI indicated that petroleum hydrocarbon contaminants were present above established cleanup limits for groundwater in the Spokane Valley Aquifer beneath the Site. Benzene, toluene, ethylbenzene, and xylene (BTEX) concentrations were well above the Washington State cleanup level requirements in groundwater (WAC 173-340-720).

Agreed Order amendments signed by Chevron, Phillips, and Tosco provided for performance and completion of the North Market Street Site Phase II RI and FS. The Phase II program was developed to further characterize and define the soil and groundwater information. The Phase II program was conducted in 1995 and was comprised of: installation and sampling of nine additional monitoring wells and two borings to bedrock; installation and sampling of 13 vapor probes; excavation and soil sampling of 89 test pits; and treatability testing of select soil samples.

The Phase II work is documented in the report titled: Final-Draft Phase II Remedial Investigation Report - North Market Street Site, Spokane, Washington, June 1996. The Phase II RI Report presents a summation of previous investigations conducted at the Site and the findings of the Phase II RI program.

The Phase II RI showed that petroleum hydrocarbon contamination is present in Site near-surface soil (less than 15 feet); in deep soil to depths of 60 feet; and in soil at the water table (smear zone) about 150 to 170 feet below ground surface. Petroleum concentrations are also present in soil vapor at depths of 100 feet and below, and continue to be present in groundwater. Petroleum in groundwater is detectable for over a distance of one mile within the Spokane Aquifer. This contaminant plume extends northwest from the Tosco facility, which is consistent with the regional groundwater flow direction.

Gasoline and diesel-range hydrocarbons were detected as high as 8 milligrams per liter (mg/L or ppm) and 13 mg/L in groundwater samples, respectively. Heavy oil range hydrocarbons were detected at 0.99 mg/L in water samples. The MTCA Method A cleanup level requirement for total petroleum hydrocarbons (TPH) in groundwater is 1 mg/L (WAC 173-340-720).

Treatability testing was conducted on individual soil samples collected from four different test pits. The purpose of the testing was to assess the biodegradation potential of petroleum hydrocarbons in soil, amount of weathering, and the treatability of the petroleum hydrocarbons in the soils. The biodegradation potential testing results indicated that over 50 percent of the petroleum hydrocarbons could be removed after treatment in three of the four samples.

Supplemental RI work was completed in July 1996. Five additional monitoring wells were installed and sampled after installation. The wells provided information on the extent of the smear zone as well as the terminus for the groundwater plume. Groundwater samples were collected again in October 1996.

4.1 Soil Contamination

The results of the investigative work indicate that petroleum hydrocarbon soil contamination is located in four main areas. The areas have been labeled as Area 1, Area 2, Area 3, and Area 4 and are shown on Figure 4. The petroleum contamination in these areas is a combination of gasoline to heavy oil range hydrocarbons. In addition, other discontinuous areas are also shown on this figure. These areas represent smaller zones where heavier asphalt-like residual compounds were encountered in relatively thin layers.

While the investigation was directed at characterizing the petroleum contamination, samples were also collected and analyzed for other potential contaminants. PCBs and pesticides were not detected in samples submitted for analyses. Select metal contamination associated with the petroleum was noted in a few test pits. The metals contamination appears to be limited in extent at the Site.

AREA 1

Area 1 was defined using the test pit and drilling data as well as the historic aerial photographs depicting the "oily-waste" ponds (Figure 4). The contamination is typically encountered from about 3 to 12 feet below ground surface (bgs). Petroleum concentrations ranging as high as 26,000 milligram per kilogram (mg/kg) are encountered in Area 1. However, contamination was discovered as deep as 40 feet bgs in the central portion of Area 1 near soil boring B-6. In addition, contamination was encountered to about 50 feet bgs near monitoring well NM-11. According to the RI report, it did not appear that the soils encountered at well NM-11 were contiguous with the oily waste pond area; however, they are included within Area 1 for cleanup discussion.

The southern portion of Area 1 appears to contain the deepest penetration of petroleum compounds in comparison with the northern portion of the area. This portion of Area 1 is a topographic low, and is ponded during periods of heavy rainfall. From the test pits excavations, it appears that most of the southern portion of Area 1 is mantled with sand fill and/or construction-debris fill. The fill appears to average two to five feet in thickness. In the vicinity of well NM-11, the fill appears to be on the order of ten feet thick.

The petroleum contamination in Area 1 consists predominantly of diesel range hydrocarbons with gasoline and heavy oil range hydrocarbons present. BTEX components and polycyclic aromatic hydrocarbons (PAHs) are also present.

AREA 2

The Area 2 delineation was based on petroleum-affected soils encountered during the test pit excavations and soil borings, and historical photos showing a drainage pond originating in the vicinity of the eastern edge of the original refinery (Figure 4). This area is located mostly within the existing tank farm. Several tanks have been constructed over this area, along with interconnecting pipelines, which has somewhat limited exploration in the area. Sand backfill about two to three feet thick mantles the area. Based on soil borings, the depth of petroleum-affected soil extends to about 15 to 20 feet bgs.

The petroleum contamination in Area 2 consists predominantly of heavy oil and diesel range hydrocarbons with minor amounts of gasoline hydrocarbons present. The contamination is as high 2,400 mg/kg in this area. PAH and BTEX components were present in soil samples.

AREA 3

Area 3 was delineated based on petroleum-affected soils encountered during the boring and test pit excavations. Petroleum concentrations ranged as high as 20,000 ppm in Area 3. This area is located adjacent to and within the bermed area of Tank 491 (Figure 4). Most of the area is mantled with a sand fill that on average appears to be approximately three feet thick. Based on soil boring NM-V1, the affected soil appears to extend to about 17 feet bgs. The petroleum contamination in Area 3 is mostly diesel range organics with some gasoline and heavy oil range hydrocarbons. PAHs and BTEX compounds were also detected in soil samples.

AREA 4

The outline of Area 4 (Figure 4) was based on the observation and sample results from test pit TSW-41, soil boring NMB-101, and soil samples collected during the drilling of monitoring well NM-9. The lateral extent of this area was not determined, in part because of the density of active buried tank farm pipelines in the area limiting the number and location of test pits.

Soil contamination consists mostly of diesel and heavy oil range hydrocarbons with gasoline range also present. The soil contamination encountered in Area 4 ranged as high as 1,100 ppm.

4.1.1 Smear Zone

The smear zone is a layer of petroleum contaminated soil that resides near the water table. The smear zone resulted from the movement of free-phase petroleum floating on the water table in the direction of groundwater flow. As the petroleum moves along the groundwater flow path, some of the free-phase adheres to soil particles and fills soil pore spaces. As seasonal water levels fluctuate, the available free product is "smeared" vertically and laterally through the soil profile. As shown on Figure 5, the smear zone extends approximately 3,500 feet northwest of the facility boundary and ranges in thickness from nine feet near NM-17 to about three feet near NM-26.

Petroleum vapors are present in Site soil above the water table. During sampling, soil vapors were collected in Tedlar bags and analyzed for gasoline range hydrocarbons (WTPH-G) and benzene, toluene, ethylbenzene, and xylenes (EPA Method 8020). The vapor sampling locations are shown on Figures 6, 7, and 8. In addition, field measurements were made for volatile organic compounds using a photoionization detector and for oxygen using an oxygen detector.

The highest vapor concentrations have been measured within the north-central portions of the existing tank farm near probes NM-V2, NM-V3, and NM-11V (Areas 2 and 5) from 100 feet to the water table. High vapor concentrations ranging from 700 to 1,700 parts per million per volume (ppmv) were also observed near Tank 302 where a spill occurred in 1989.

The vapor concentrations appear to vary in some wells over time. The variations may be related to seasonal atmospheric pressure changes that cause an exchange of air/vapor in the probe well casings. During sampling, this exchange can be observed either as vapor flow out of the well or airflow into the well.

4.2 Groundwater Contamination

Groundwater contamination was confirmed in the North Market Street Site area as early as August 1984. During the November 1994 sampling program, free-phase floating hydrocarbon was discovered in wells NM-4, NM-5, NM-11, NM-12, NM-13, NM-16 and TW-2 (Figure 5). Samples of product from wells NM-4, NM-5, NM-11, NM-13, NM-16 and TW-2 were analyzed to assess the types of product present using a fuel fingerprinting analysis. These analyses indicate that the product appears to be similar to mixtures of gasoline or kerosene with diesel, gasoline and diesel, kerosene and diesel, and diesel fuel.

Free product was also observed during the June 1995 and October 1995 sampling rounds. The number of wells where free product was measured was considerably less during

these sampling rounds than the November 1994 round. The free-phase hydrocarbons were observed in wells that are screened in the "smear-zone" located near the water table.

Since the 1994 sampling round, the observance and thickness of free product has declined. The intermittent detection of free-phase hydrocarbons in the wells is likely the result of a fluctuating water table. Several additional factors have contributed to the decline in product thickness at the Site. These factors include the smearing of the product within the smear zone as well as the transport and redistribution of the contamination within the plume boundaries. Natural attenuation and dilution and dispersion have also contributed to the decline in free product and hydrocarbons present within the system.

4.2.1 Gasoline Range Hydrocarbons

Gasoline-range hydrocarbons (C7 to C12) have been detected in wells screened at the top of the aquifer, near the water table. Gasoline was not detected above detection limits in bedrock wells, upgradient wells or wells screened below the smear zone. The historically highest concentrations in water table wells have ranged from 3.7 to 8 milligrams per liter (mg/L) (Wells NM-4 and NM-11, 1995, respectively). There have been similar declines in WTPH-G concentrations in other wells on site when free product is not present.

Benzene toluene, ethylbenzene and xylenes (BTEX) have been detected in wells where gasoline-range hydrocarbons were present. Benzene concentrations have also declined in most site wells over time. For example, in wells NM-11, a benzene concentration of 74 micrograms per liter (ug/l) was reported for well NM-11 in 1993. During the September 1999 round, the benzene level has declined to 30.3 ug/l. There have been similar declines in benzene concentrations in other wells on site. The ethylbenzene, toluene, and xylene constituent concentrations have also varied in generally the same way.

4.2.2 Diesel and Heavy Oil Range Hydrocarbons

As with the gasoline-range hydrocarbons, diesel-range hydrocarbons (C12 to C24) were observed in wells screened near the water table. Diesel was not reported above detection limits in upgradient wells, the deeper wells screened below the smear zone, or in bedrock wells.

The highest concentrations of diesel-range hydrocarbons were detected in wells screened across the water table. Concentrations ranged from 0.31 mg/L up to 13 mg/L. Heavy oil was detected in samples collected from monitoring wells NM-5 and NM-16. Concentrations were 0.6 mg/L and 0.99 mg/L, respectively. Similar to the WTPH-G and BTEX trends, diesel-range hydrocarbon concentrations have also declined over time. Heavy oil range hydrocarbons have not been detected in site wells (detection limit 0.75 mg/L) since May of 1998.

Semivolatile organic compounds (SVOCs) such as naphthalene, fluorene, phenanthrene, and 2-methylnaphthalene are generally associated with diesel and heavy oil range

hydrocarbons. Naphthalene was the most commonly detected SVOC followed by 2-methylnaphthalene.

Naphthalene concentrations ranged from 76 ug/l in NM-4 to non-detectable in NM-9. 2-Methylnaphthalene levels varied from non-detectable at 10 ug/l to 91 ug/l. The highest fluorene and phenanthrene concentrations were 4.4 ug/l and 8.3 ug/l respectively.

4.2.3 Metals

Metals have been analyzed in over 70 groundwater samples. Total and dissolved metals were analyzed with the dissolved metals samples being filtered through a 0.45-micron filter prior to preservation.

Arsenic, lead, and manganese are the only metals detected in several wells above their respective MTCA Method A and Method B cleanup levels. Total arsenic levels as high as 220 ug/l with a corresponding dissolved concentration of 87 ug/l (well NM 9, November 1994) have been detected at the site. The total arsenic level is likely influenced by turbidity of the sample as supported by the lower value in the dissolved sample. Lead sample results suggest that the elevated lead concentrations identified at the Site are a result of high turbidity in samples. This is supported by the limited detection of lead in the dissolved samples. Manganese concentrations range from below detection limits to 2,600 ug/l.

The metals occurrence within the contaminant plume is the result of anaerobic conditions produced from the petroleum hydrocarbon contamination. While the metal contamination is a by-product of the petroleum impacts, their presence increases the overall toxicity of the groundwater. Therefore, metals will be addressed as part of the cleanup action.

4.3 Additional Investigations

Supplemental remedial investigation activities were performed in July 1996. This additional work included the drilling and sampling of five monitoring wells and quarterly groundwater and soil gas sampling for other Site wells. The purpose of the work was to further define the northwestern end of the groundwater contamination plume. Another round of quarterly monitoring was completed in October 1996. The newly installed monitoring wells framed the end of the groundwater plume and petroleum contamination was not detected in the distal wells at the time.

Ecology and their contractor (SAIC) conducted a groundwater and soil gas sampling event at the Site in May 1998. Groundwater was collected from 16 monitoring wells for laboratory analysis, and 18 were sampled for total petroleum hydrocarbons, select metals, nitrate, nitrite, sulfate, and ammonia.

An Enforcement Order was issued to the North Market Street Group in June 1998 for the completion of four soil borings to the smear zone. Soil samples collected from the smear zone were submitted for treatability testing to assess the biodegradability of the smear

zone. Quarterly groundwater and soil gas monitoring and monthly water level measurements were also included in the work scope. The quarterly monitoring was completed in September 1999.

DOF completed an additional investigation to evaluate possible TPH cleanup levels for the Site in October 1998. Five test pits were excavated and sampled by DOF. Soil samples were submitted for analysis utilizing laboratory techniques specified in the Washington State Department of Ecology Toxic Cleanup Program Interim Interpretive and Policy Statement for Cleanup of Total Petroleum Hydrocarbons, January 1997. While there is not a direct correlation, the laboratory results using the Interim TPH Policy methods provided a reasonable comparison with the sample data collected previously using standard Ecology TPH laboratory testing techniques.

5.0 CLEANUP STANDARDS

The cleanup standard development process is used to determine which hazardous substances or indicator substances contribute to the overall threat to human health and the environment at the Site. Once these indicator substances are identified, an evaluation is made to determine at what concentration these substances are considered to be protective of human health and the environment. A point of compliance is then established on the Site, which is a point or points where these cleanup levels must be attained (WAC 173-340-200).

MTCA provides three main methods for establishing cleanup levels at a Site. These are Methods A, B, and C. Method A provides cleanup levels for routine cleanup actions or sites with relatively few hazardous substances. Methods B and C cleanup concentrations are calculated from applicable or relevant and appropriate requirements (ARARs) and from using the formulas provided in WAC 173-340 720 through WAC 173-340-760. Method B is the standard method for establishing cleanup levels and is applicable to all sites. Method C is a conditional method for use at sites subject to specified uses.

Following establishment of cleanup levels, media having concentrations above cleanup levels must be addressed using one or more technologies selected as part of the remedy. Criteria for remedy selection are outlined in WAC 173-340-360.

Soil and groundwater are the two media contaminated at the North Market Street Site. Several hazardous substances have been identified in these media and their distribution is complex, making sole reliance on Method A cleanup levels inappropriate.

The predominant contaminant in Site soil is total petroleum hydrocarbons (TPH). Ecology's Interim TPH Policy (1/97) in conjunction with other applicable cleanup level methods will be used to set cleanup levels at the North Market Street Site. The Interim Policy utilizes a surrogate approach that allows the use of specific carbon fraction ranges to represent the entire petroleum mixture. Two exposure pathways are considered when using the new policy. These pathways are direct human contact and the protection of groundwater. Since the Site is located in a commercial and industrial multi-use area, the

most stringent reasonable maximum exposure scenario was selected, and therefore, Method C commercial cleanup levels will be applied to Site soil. Institutional controls guaranteeing this land use are required for the Method C exposure scenario.

Groundwater cleanup standards are set according to WAC 173-340-720. The highest beneficial use of Site groundwater is as a current and future drinking water source. Ecology has determined that the reasonable maximum exposure expected is through ingestion of drinking water and other domestic uses [WAC 173-340-720 (1) (a)]. A Method B cleanup standard will be used for establishing cleanup levels in groundwater at the Site.

5.1 Indicator Substances

Indicator substances as defined by WAC 173-340-200 are a subset of hazardous substances present at a site selected under WAC 173-340-708 for monitoring and analysis during any phase of remedial action for the purpose of characterizing the site or establishing cleanup requirements for the site.

As discussed above total petroleum hydrocarbons with associated chemicals and select metals have been identified as chemicals of concern at the Site. Indicator substances will be selected from the list of chemicals of concern. The criteria found in WAC 173-340-708 (2) (b) are used to screen the list of chemicals. Following the selection of indicator substances, cleanup levels are developed for the list of substances that are used to calculate the total site risk. Protection of groundwater is considered in conjunction with exposure scenarios. For non-carcinogenic substances, the summation of risk for each toxic endpoint of all media must not exceed a hazard index of one. For establishing cleanup levels of carcinogenic substances, the total cancer risk from all chemicals in the affected media must not be greater than one in one hundred thousand or 1×10^{-5} .

5.1.1 Soil Indicator Substances

The mostly likely pathway for human exposure at the Site is through direct contact or ingestion. Reasonable maximum exposure scenarios for the Site will be a commercial setting. TPH, and the volatile organic compounds of benzene, toluene, ethylbenzene, and xylene meet the criteria of being indicator substances for soil. Table 1 presents the soil indicator substance screening results. While the carcinogenic polycyclic aromatic hydrocarbons as individual substances were not retained for further cleanup level development since their detection percentage was not above five percent, their presence in aggregate will be retained as an indicator substance and affect the remedy selected for the soil remediation.

TPH is the main contaminant at the Site and the PAH and BTEX components are associated with the TPH contamination. Therefore, TPH will be the chemical used to select the cleanup remedy at the Site. The TPH cleanup will result in the cleanup of the other indicator substances.

5.1.2 Groundwater Indicator Substances

As discussed previously, the most beneficial use of Site groundwater is as a current and future drinking water source since Site groundwater is part of the Spokane-Rathdrum Sole Source Aquifer system. Exposure through ingestion and other domestic uses is the main groundwater pathway. TPH, arsenic, manganese, and BTEX will be used as indicator substances for groundwater. Groundwater indicator substance screening results are presented as Table 2.

As with the soil, TPH is the dominant contaminant in the groundwater system. The arsenic and manganese contamination appears to be a result of the anaerobic conditions within the groundwater plume. These anaerobic conditions are a result of the TPH plume. Since TPH is the main contaminant and other indicator substances are associated with the TPH, the selected remedy will focus on cleanup of the TPH.

5.2 Cleanup Standard Development

The indicator substance screening yielded six soil contaminants and seven groundwater contaminants that will be carried forward for cleanup standard development. The soil cleanup levels will be developed to be protective of human health via direct contact and groundwater protection. Groundwater cleanup levels will be set to be protective of human health via ingestion and other domestic uses.

5.2.1 Soil Cleanup Levels

Soil cleanup levels set under Method C commercial standards must be consistent with applicable state and federal laws and at least as stringent as the following:

- i) Concentrations will not cause contamination of groundwater at levels that exceed groundwater cleanup levels established under WAC 173-340-720.
- ii) For those hazardous substances for which health-based criteria or standards have not been established under applicable state and federal laws, those concentrations which protect human health as determined by the risk based equations of WAC 173-340-745 (4)(a)(iii)(A) and (B) for non-carcinogenic and carcinogenic effects.

Table 3 presents the Interim TPH Policy table that was used to set cleanup levels for TPH and the BTEX components. The Interim Policy requires that a dilution factor (DF) of one (1) be used when contaminated groundwater is present and the resulting concentration "at well" cannot exceed 1 milligram per liter (mg/L). Groundwater cleanup levels for the BTEX components must also be met with the resulting "at well concentrations." The hazard quotient summation or hazard index must be less than one and the total risk cannot exceed 1×10^{-5} .

A TPH cleanup level of 6,000 ppm was derived using the Interim TPH Policy. The benzene cleanup level is 0.5 ppm and the carcinogenic PAH cleanup level is 1 ppm.

Ethylbenzene and xylene cleanup levels are set at the Method A level of 20. The toluene cleanup level is set at 40 ppm. A hazard quotient of 0.61 and a total risk of 1.83×10^{-6} was produced with the cleanup level set at 6,000 ppm. The resulting modeled concentration at the well was 0.9780, just under the required 1 mg/L.

As shown on Table 4, the hazard index of 0.61 was used for every toxicity category. Ecology assumes that petroleum hydrocarbon is applicable to each toxicity endpoint since there is no published information to suggest differently. The soil hazard index will be added to the hazard index developed from the groundwater cleanup levels.

5.2.2 Groundwater Cleanup Levels

Groundwater cleanup levels set under Method B must be at least as stringent as the criteria in WAC 173-340-720 (3)(a), which includes the following:

- i) Concentrations established under applicable state and federal laws, including the requirements in WAC 173-340-720 (2)(a)(ii), which includes the following:
 - (A) Maximum contaminant levels (MCLs) established under the Safe Drinking Water Act and published in 40 C.F.R.141, as amended;
 - (B) Maximum contaminant levels goals for noncarcinogens established under the Safe Drinking Water Act and published in 40 C.F.R.141, as amended;
 - (C) Secondary maximum contaminant levels established under the Safe Drinking Water Act and published in 40 C.F.R.143, as amended; and
 - (D) Maximum contaminant levels established by the state board of health and published in Chapter 248-54 WAC, as amended.
- ii) For hazardous substances for which sufficiently protective, health-based criteria or standards have not been established under applicable state and federal laws, those concentrations which protect human health as determined by the equations presented in WAC 173-340-720 (3)(ii)(A) and (B).

Table 5 presents the Method A and B cleanup levels for groundwater. Method A cleanup levels were used for five contaminants, TPH, ethylbenzene, toluene, xylene, and arsenic. Therefore, these parameters were not used in the equation to calculate Site risk. The Method A cleanup levels were used for TPH and lead in groundwater since there are currently no Method B or C cleanup levels. Method A levels were used for ethylbenzene, toluene, and xylene since they are the most stringent cleanup level. A Method A cleanup level was used for arsenic since it appears to be associated with the TPH and is near background levels based on upgradient monitoring well concentrations. Additionally, a Method A cleanup level is protective. The cleanup level for TPH is 1,000 micrograms per liter (ug/l or ppb). The ethylbenzene cleanup level is 30 ppb and the cleanup level

for toluene is 40 ppb. The xylene cleanup level is set at 20 ppb. The cleanup level for arsenic is 5 ppb. The benzene MCL was used to set the cleanup level of 5 ppb.

5.3 Overall Site Risk

The total Site risk and hazard quotient calculations are presented as Table 6. The risk associated with the carcinogenic substances at the Site is 5.14×10^{-6} . This is derived from a combination of risk associated with benzene in groundwater and PAHs in soil. The effects from non-carcinogenic substances were used to determine the hazard index by summation of the hazard quotients. The highest calculated hazard index is 0.632 for the neurotoxicity category.

6.0 REMEDIAL ALTERNATIVES

The FS identified four alternatives for soil remediation and five alternatives for groundwater remediation. The soil remediation alternatives separate the smear zone from the other surface and near-surface affected soils. The soil alternatives are listed below.

6.1 Soil Remedial Alternatives

Alternative S-1 – Institutional Controls and Monitoring

This alternative involves the use of institutional controls to prevent exposure to contaminated soil. A portion of the Site is currently fenced and access limited to prevent direct exposure. Monitoring will involve collecting soil vapor from vapor monitoring points located at the Site boundary.

Alternative S-2 – Excavation, On-site Confinement and Bioventing

Excavation

Accessible hydrocarbon-impacted soil is excavated and confined beneath a cap. Soil is excavated to the TPH cleanup level. Vapor monitoring of the capped material and areas inaccessible for removal that still exceeds cleanup levels is implemented.

The deposits assumed accessible to excavation include Area 1 and about forty percent of Areas 2 and 4. The soil in Areas 3 and 5 is biovented along with deep soil along the axis formed by wells NM-11V and NM-V2. The soil vapor extraction would be restarted. Excavations would be backfilled with clean fill and compacted. Appropriate institutional controls and monitoring are implemented in conjunction with the cleanup.

Confinement

The consolidation and capping of soil would occur in the northwest corner of the Tosco property and southwest portion of the Draper property. The location in

Area 1 contains the largest volume of contaminated soil, which could be left in place. The area is not occupied by any facilities and cannot be used in its current condition.

The excavated material would be consolidated in the confinement area and capped. The cap would prevent direct contact, minimize infiltration of stormwater through the contaminants, and prevent surface erosion. An asphalt concrete pavement was selected as the cap material.

Bioventing

Bioventing consists of injecting air into the subsurface and providing oxygen for the bioremediation of petroleum hydrocarbons. Since Area 3 cannot be completely excavated and it contains light-end hydrocarbons that are amenable to treatment, this area will be biovented. Bioventing will also be used in the area between NM-11V and NM-V2.

Monitoring

A monitoring and inspection program is implemented at the end of the remedial activities. The cap is routinely inspected and repaired as required. Soil vapor monitoring is conducted at the perimeter of the confinement area and around residual areas of contamination to assess the degree of hydrocarbon migration.

Alternative S-3 – Excavation, Thermal Treatment, and Bioventing

This alternative utilizes the same assumptions as the excavation and bioventing scenario presented in Alternative S-2. A thermal desorption system will be mobilized to the Site and treat the excavated soil to below MTCA Method A cleanup levels of 200 ppm. The treated soils will be used as backfill following confirmational testing.

Alternative S-4 – Excavation, Off-site Disposal, and Bioventing

This alternative utilizes the same assumptions as the excavation and bioventing scenario presented in Alternative S-2. The excavated soil will be disposed off-site in an approved landfill. Clean imported soil will be used to backfill the excavations. Institutional controls and monitoring will be conducted as described previously.

6.2 Groundwater Remedial Alternatives

Alternative GW-1 - Institutional Controls and Monitoring

This alternative relies on natural degradation processes to control and limit migration of the dissolved constituents from the smear zone. Institutional controls would be implemented to restrict development of the groundwater resource near

the smear zone. Long-term monitoring of dissolved hydrocarbons, arsenic, and manganese is needed to track containment and recovery.

Alternative GW-2 – Air Sparging Near NM-26

Natural remedial processes are enhanced by sparging air into the aquifer near the downgradient edge or fringe of the smear zone. An array of wells is constructed cross-gradient to groundwater flow near Well NM-26. Air is injected into the aquifer approximately 15 feet below the smear zone. The sparge air increases the dissolved oxygen in the groundwater, thereby stimulating in-situ biodegradation. This reduces the size of the dissolved plume downgradient. In addition, volatile constituents are stripped from groundwater and transported to the vadose zone. Oxygen emerging into the vadose zone from the sparge wells promotes further biodegradation of hydrocarbons. Sparging also reduces the dissolved arsenic and manganese by elevating the redox potential. A performance monitoring program is implemented to assess the effectiveness of air sparging. Compliance monitoring is also conducted to periodically determine constituent concentrations at the established point of compliance.

Alternative GW-3 – Air Sparging Near NM-22 and NM-26

This alternative is similar to Alternative GW-2 and includes an additional zone of groundwater air sparging near the neck of the smear zone. The array of sparge wells in the smear zone reduces the concentration of dissolved hydrocarbons in the immediate area downgradient of the wells and transports dissolved oxygen downgradient of the wells to stimulate biodegradation.

Alternative GW-4 – Air Sparging Near NM-22, NM-26, and Site Boundary

This alternative is similar to Alternative GW-3 and includes an additional sparge front near the fuel terminal property boundary and crosses the Burlington Northern Railroad tracks. The smear zone is effectively divided into three “remediation units” with this alternative. The concepts of remediating the smear zone and transporting dissolved oxygen downgradient of the sparge front to stimulate biodegradation are applicable with this alternative also.

Alternative GW-5 – Containment by Extraction, Treatment, and Reinjection

This alternative involves pumping groundwater from the aquifer to prevent downgradient migration of contaminants. Groundwater extraction wells would be placed downgradient of the smear zone. Groundwater would be extracted and pumped into a treatment system. Once the treated water met drinking water criteria, it is reinjected downgradient or upgradient of the extraction zone. Monitoring is conducted to determine the concentrations at the point of compliance.

6.3 Cleanup Action Criteria

The criteria used to evaluate cleanup actions are presented in WAC 173-340-360. All cleanup actions must meet the following four threshold requirements:

- Protect human health and the environment
- Comply with cleanup standards set forth in WAC 173-340-700 through 760
- Comply with applicable state and federal laws
- Provide for compliance monitoring

Other requirements under this section include the following:

- Use permanent solutions to the maximum extent practicable
- Provide for reasonable restoration time frame
- Consider public concerns raised during the public comment period on DCAP

Ecology has a higher preference for cleanup technologies that minimize the amount of untreated hazardous substances remaining at a Site. These cleanup action technologies are prioritized and listed in a descending order of preference.

- i) Reuse or recycling;
- ii) Destruction or detoxification;
- iii) Separation or volume reduction followed by the technologies above;
- iv) Immobilization of hazardous substances;
- v) On-site or off-site disposal at an engineered facility designed to minimize future releases of hazardous substances in accordance with applicable state and federal laws;
- vi) Isolation or containment with attendant engineering controls; and
- vii) Institutional controls and monitoring

Preference is also given to cleanups that provide permanent solutions to the maximum extent practicable. Criteria are developed to determine whether a cleanup meets this objective. The criteria include the following:

- Overall protection of human health and the environment
- Long term effectiveness
- Short-term effectiveness
- Permanent reduction of toxicity, mobility, and volume
- Implementability
- Cleanup costs when selecting from among two or more cleanup actions that have an equivalent level of preference under WAC 173-340-360 (4).

6.4 Evaluation of Proposed Remedial Alternatives

The remedial alternatives proposed in the feasibility study were evaluated according to the criteria set forth in WAC 173-340-360 and discussed in the prior section of this

report. Three of the four soil alternatives meet the threshold requirements to varying degrees. Four of the five groundwater alternatives meet the threshold requirements. The alternatives will be listed with high, moderate or low ranking for protectiveness of human health and the environment.

6.4.1 Soil Alternatives

Alternative S-1 relies primarily on institutional controls and monitoring while there are cleanup actions available that are technically possible to implement and utilize a higher preference cleanup technology. This alternative does not meet the MTCA cleanup action criteria, and therefore, it is not an acceptable cleanup action.

Alternative S-2 is moderately protective of human health and the environment. This alternative meets the remaining three threshold requirements. However, this cleanup action does not use permanent solutions to maximum extent practicable and utilizes a lower preference cleanup technology. The alternative can be easily implemented and provides for monitoring.

Alternative S-3 is ranked high for protectiveness and meets the other threshold requirements. The proposed cleanup action utilizes a permanent solution to the maximum extent practicable and employs a higher preference cleanup technology. The alternative is implementable and provides a monitoring component.

Alternative S-4 is considered moderately protective of human health and the environment. While the surface and near-surface contaminated soil is removed from the Site, there is no volume or toxicity reduction in the hazardous substances. This alternative meets the remaining three threshold requirements. This cleanup action does not use permanent solutions to maximum extent practicable and utilizes a lower preference cleanup technology. The alternative can be easily implemented and provides for monitoring.

6.4.2 Groundwater Alternatives

Alternative GW-1 relies primarily on institutional controls and monitoring while there are cleanup actions available that are technically possible to implement and utilize a higher preference cleanup technology. This alternative does not meet the MTCA cleanup action criteria, and therefore, it is not an acceptable cleanup action.

Alternative GW-2 is ranked high with regard to protectiveness and fulfills the other threshold requirements. The cleanup action utilizes a higher preference technology to destroy the contaminants with biodegradation. The alternative can be easily implemented and provides for monitoring.

Alternatives GW-3 and GW-4 are variations of alternative GW-2 and provide additional sparge wells, which will provide additional promotion of biodegradation of the contamination.

Alternative GW-5 is highly protective and can meet the other threshold requirements. The alternative uses a higher preference cleanup technology to extract and destroy the contaminants in the groundwater. This alternative can be implemented and provides for long-term monitoring.

7.0 CLEANUP ACTION PLAN

The selected cleanup action for the North Market Street Site addresses the contamination in soil and groundwater. The cleanup action plan meets the threshold requirements and the MTCA preference for permanent solutions to the maximum extent practicable. Ecology selected alternatives similar to those presented in the FS.

7.1 Soil Cleanup

The soil cleanup is divided into two components, a shallow soil and deep soil discussion. For the purpose of this discussion, soils will be considered shallow to a depth of 15 feet below ground surface (bgs). This depth will meet a point of compliance via direct contact and represents a reasonable estimate of soil depth that could be excavated and distributed at the soil surface as a result of Site development activities (WAC 173-340-740 (6)(c)). The contamination, excluding Area 1 and the smear zone, appears to be shallower than 15 feet bgs.

The selected soil cleanup is similar to soil alternative S-3 presented in the feasibility study. Soil will be excavated in areas accessible to common excavation equipment and that does not endanger current fuel terminal operations. A mobile thermal desorption unit will be mobilized onto the Site for treating soil. The excavated soil will be thermally treated to below 200 mg/kg TPH and placed on the Site as backfill. If an on-site thermal desorption unit is not available, off-site thermal treatment will be utilized. Laboratory testing will be required for treated soil prior to placement as backfill.

The areas to be excavated are Area 1, Area 2, Area 3, and Area 4. Area 1 has the majority of contaminated soil at the Site, and the soil is readily accessible for excavation. As discussed, for estimation purposes soils considered for excavation will be to a depth of 15 feet bgs.

Area 2 encompasses the property near Tanks 102 and 155. As shown on Figure 9, the accessible materials in Area 2 for excavation are near the head and tail of the contaminant outline. The contamination in this area appears relatively shallow, less than 10 feet.

Area 3 is located in the berm of Tank 491 (Figure 4). Samples collected during the investigations suggest that contaminated surface soil extends to about 10 feet bgs. The soil in this area can be excavated and removed for thermal treatment. During the remedial design, a setback from Tank 491 can be determined prior to excavation and then field observations will determine the amount of soil removed.

Based on the previous investigations, the contaminated soil in Area 4 appears to be limited in extent. The contamination is limited to the area near NM-9 (Figure 4). The remainder of the area appears to be below cleanup levels. The soil will be excavated and thermally treated.

The estimated volume of soil that would require excavation in Area 1 is about 67,000 cubic yards. After removing approximately 14,000 cubic yards of surficial clean fill (the upper 2 to 3 feet), an estimated 53,000 cubic yards would require treatment. For Area 2, an estimated 5,500 feet of soil would require excavation, with approximately 4,500 cubic feet requiring treatment. In Area 3, approximately 2,700 cubic yards would require excavation with an estimated 2,000 cubic yards requiring treatment. In Area 4, approximately 600 cubic yards would require excavation with an estimated 500 cubic yards requiring treatment. The total estimated volume of soil that would require treatment at the site is 60,000 cubic yards. The clean overburden soils, estimated to be approximately 15,800 cubic yards for the entire site, would be stockpiled and replaced following replacement of the treated soils. The soil contamination is visually distinctive. Field observation will determine the actual amount of soil excavated for treatment.

The deep soil will be biovented as an in-situ treatment, which will result in destruction of contaminants in the subsurface. Petroleum degrading bacteria are present in the subsurface and limited natural biodegradation appears to be occurring. Enhanced degradation of the contaminant mass will be stimulated through bioventing.

Soil vapors are present in Area 1 from 50 feet bgs to the water table as indicated by soil vapor probes NM-V4 (50'), NM-V4 (100'), and NM-V3 (149'). This probe area coupled with the vapors present in Area 5 and near Tank 302 indicates the presence of an extensive contaminant vapor cloud. In Area 2 soil vapors are present in vapor probes NM-V2 (50' and 100'). The vapors do not appear to be as significant at 50 feet; however, the vapors at 100 feet are high. Bioventing will be utilized in this area also.

Soil vapor extraction (SVE) will not be used to address the deep soil vapors or smear zone. SVE would require the treatment of soil vapors on surface. However, the former SVE system might be utilized as part of the bioventing system. The bioventing well and system location and design will be determined during the remedial design phase.

7.2 Groundwater Cleanup

Groundwater contamination continues to be present on and off-site. The highest beneficial use of Site groundwater is as a drinking water source, particularly since the groundwater occurs within a "sole source aquifer." The groundwater contaminant plume extends from the facility boundaries in a northwesterly direction for approximately 4,400 feet to monitoring well NM-30. The contaminant plume appears to have a distinct transition boundary from where emergent free-phase hydrocarbons are observed and dissolved-phase hydrocarbons are present.

The selected remedy for groundwater is similar to groundwater alternative GW-2. The remedy utilizes one line of sparge wells at a different location than the location presented in the FS. The line of air sparging wells will be placed in the area between monitoring wells NM-18 and NM-22, east of NM-20 with a configuration perpendicular to the plume (Figure 10). This area is the narrowest portion of the plume and is the transition area of free-phase and dissolved hydrocarbon contamination. The sparge line will be used to enhance the natural degradation that is taking place within the system and minimize the effects of emergent free product that dissolves and moves through the system. Monitored natural attenuation will be used as the remedial tool for the remainder of the contaminant plume.

Natural attenuation is occurring in groundwater as evidenced by an oxygen depleted or anaerobic plume core and consumption of other electron donors such as sulfate and nitrate within this core. However, anaerobic degradation of hydrocarbons is rate limited in comparison to aerobic degradation. Given the inadequate contamination attenuation rates in the anaerobic zone, and static contaminant concentrations adjacent to the plume core, Ecology has concluded that enhanced natural attenuation technologies are necessary in the vadose and saturated zones. Ecology believes that dilution and dispersion is contributing equally if not more than natural attenuation to a reduction in contaminant concentrations. Sole reliance on dilution and dispersion is not acceptable [(WAC 173-340-360 (5)(e)(iii))], particularly if active remedial measures are technically possible.

The implementation of air sparging technology will improve the aerobic microbial metabolism of the petroleum hydrocarbons and reduce the elevated metals concentrations that have resulted from the anaerobic groundwater conditions. The sparging system will also provide a barrier to contain persistent mobile organic chemicals traveling within the plume path.

7.3 Point of Compliance

A point of compliance (WAC 173-340-200) is the point or points where cleanup levels established in accordance with WAC 173-340-720 through 173-340-760 shall be attained. Once those cleanup levels have been attained at that point, the Site is no longer considered a threat to human health and the environment.

For human exposure scenarios via direct contact, the soil point of compliance is set from ground surface to 15 feet bgs. Direct contact can result in chemicals being absorbed through the skin or ingested by either eating or inhaling contaminated soils. These exposure scenarios are considered unlikely below 15 feet bgs. Since soil cleanup levels are also based on protection of groundwater, the compliance point is set throughout the Site [WAC 173-340-740 (6)(b)].

The groundwater point of compliance is established throughout the Site from the uppermost level of the saturated zone extending vertically to the lowest most depth which could potentially be affected by the Site [WAC 173-340-720 (6)(b)]. Where hazardous substances remain on-site as part of the cleanup action, a conditional point of compliance

which shall be as close as practicable to the source of hazardous substances not to exceed the property boundary may be used. If a conditional point of compliance is used, the proponent shall demonstrate that all practicable methods of treatment are to be utilized in the cleanup action [WAC 173-340-720 (6)(c)]. The point of compliance will be set at the property boundary and will be monitored with monitoring wells NM-11 and TW-2 (Figure 5). Ecology will consider the placement of additional monitoring wells and/or replacement monitoring wells that may better reflect conditions at the point of compliance.

7.4 Institutional Controls

Institutional controls are measures undertaken to limit or prohibit activities that may interfere with the cleanup action or result in the exposure to hazardous substances at the Site. Institutional controls are required where cleanup actions result in residual concentrations of hazardous substances exceeding cleanup levels established for the Site. These controls may not be used as a substitute for a cleanup that is technically possible.

If Method C is used to develop cleanup levels for Site soil, restrictive covenants must be placed on the property. Restrictive covenants do not have to be placed on the property if the cleanup achieves soil cleanup levels using the Method B residential criteria in the Interim TPH Policy. Table 7 presents the cleanup level for the Method B residential cleanup scenario. As shown, a cleanup level of 3,000 ppm is considered protective in a residential scenario. The selected cleanup remedy should address the contamination to concentrations below 3,000 ppm, thus, eliminating the need for restrictive covenants. Contaminated soil within the smear zone will be addressed with institutional controls established for the groundwater.

Groundwater contamination occurs on the fuel terminal property and beyond the property boundaries. Institutional controls will be required that prohibit and/or limit groundwater extraction or use near the groundwater contamination plume. If groundwater use is proposed near the plume, a demonstration must be provided for Ecology's review that shows the groundwater plume will not be affected by the usage.

8.0 EVALUATION OF CLEANUP ACTION WITH MTCA CRITERIA

The selected remedy will be evaluated with the MTCA criteria set forth in WAC 173-340-360.

8.1 Protection of Human Health and the Environment

Soil and groundwater are the contaminated media at the Site. The exposure routes expected at the Site are via direct contact and ingestion of soil and groundwater with a secondary exposure route through air. The excavation and destruction of the TPH in soil through thermal treatment will remove the contaminant source, reduce the risk from direct contact and provide for protection of groundwater.

Groundwater treatment utilizing air sparging will reduce the contaminant mass. The contaminant reduction coupled with institutional controls restricting groundwater use will limit exposure via ingestion and dermal contact.

8.2 Compliance with Cleanup Standards

Shallow contaminated soil above cleanup standards will be excavated and thermally treated to below standards. The soil vapors and contamination in the smear zone will be treated with bioventing. The bioventing will assist in the degradation of contaminants at the water table.

Air sparging and natural attenuation will continue to move the contaminated groundwater toward the cleanup standards. Institutional controls will be part of this cleanup action since contamination above cleanup levels will remain on-site in the smear zone and groundwater.

8.3 Compliance with Applicable State and Federal Laws

The North Market Street Cleanup Action Plan complies with applicable state and federal laws. The applicable state and federal laws for the implementation of the cleanup action are identified in Table 8. Local laws, which are more stringent, will govern actions when they are applicable.

8.4 Compliance Monitoring

Compliance monitoring is divided into three categories: protection, performance, and confirmational (WAC 173-340-410). Protection monitoring is designed to protect human health and the environment during construction and the operation and maintenance period of the cleanup action. Performance monitoring confirms that the cleanup action has attained cleanup and/or performance standards. Confirmational monitoring confirms the long-term effectiveness of the cleanup action once cleanup standards have been achieved or other performance standards have been attained.

8.5 Use Permanent Solutions to the Maximum Extent Practicable

A permanent solution is one in which cleanup standards can be met without further action being required. The excavation and thermal destruction of petroleum hydrocarbons in shallow soil is considered a permanent solution under MTCA. Bioventing will promote the destruction of petroleum vapors in the subsurface as well as stimulate biodegradation of petroleum hydrocarbons in the smear zone. Bioventing is considered a permanent solution since it is a destruction technology.

The groundwater cleanup remedy that utilizes natural attenuation and air sparging is considered a permanent solution since destruction via biodegradation occurs using this cleanup technology.

8.5.1 Protection of Human Health and the Environment

The remedies selected for the soil and groundwater are considered protective of human health and the environment. The soil remedy will remove and destroy the contaminant mass in the shallow soil and attain cleanup standards. The groundwater remedy is considered protective coupled with institutional controls. The remedy will reduce the contaminant mass in groundwater and the smear zone. Achieving groundwater cleanup standards will be assessed as part of the five-year review required under WAC 173-340-420. If groundwater standards have been met at that time no further cleanup action will be required. Performance monitoring will be completed according to a schedule established in the administrative mechanism used to conduct the cleanup action.

8.5.2 Long-Term Effectiveness

Long-term effectiveness will be achieved from the destruction of TPH and the associated contaminants in soil. The long-term effectiveness of the groundwater remedy will be assessed as a reduction in contaminants is achieved through air sparging and natural attenuation. As the TPH contamination is reduced within the aquifer and aerobic conditions return, the metal contamination should also dissipate.

8.5.3 Short-Term Effectiveness

Risks associated with the cleanup action in the short term are the potential exposure of workers to the contaminated soil during excavation and treatment. Bioventing in the deep subsurface will not expose workers to vapors and potential off-site migration of vapors will be monitored. Institutional controls to prevent contact with contaminated groundwater will minimize the short-term risks while the groundwater remedy is implemented. Worker health and safety will be addressed as part of the remedial action design to comply with the appropriate regulations and to satisfy the protection monitoring requirements.

8.5.4 Permanent Reduction of Toxicity, Mobility, and Volume

Excavation and thermal treatment of TPH-affected soil will provide a permanent reduction of toxicity, mobility, and volume. Bioventing of soil vapors will reduce the vapor phase contamination and promote a reduction of contaminants in the smear zone. Air sparging and natural attenuation will also reduce the toxicity, mobility, and volume of contaminants in groundwater.

8.5.5 Implementability

The cleanup action plan can be readily implemented since it involves the use of conventional remediation technologies. Difficulty may be encountered because portions of the remedy will be implemented on properties not controlled by the PLP group.

8.5.6 Cost

The cost provided in the FS for the soil alternative is \$6,000,000 for capital costs and \$1,800,000 for present worth annual operations and maintenance (O&M) costs. These costs were developed using a nine-percent (9%) interest rate and an O&M life of 10 years for the bioventing. The estimated cost for the groundwater alternative is \$400,000 for capital costs and \$1,000,000 for annual O&M.

8.5.7 Provide Reasonable Restoration Time Frame

The proposed cleanup action will provide source control measures by removal and treatment of soil in the near surface. Bioventing will be used to address deep soil contamination and soil vapors. The biodegradation of deep soil and vapors will remove contaminants from the system that are a source of groundwater contamination. Air sparging will enhance the natural biodegradation that is occurring and provide for a shorter restoration time frame. Monitoring and periodic review will provide an assessment tool of the cleanup action.

8.5.8 Public Participation and Community Acceptance

A public comment period will be held to allow the public and parties affected by the cleanup action an opportunity to provide comment on this document. Public comments and concerns will be addressed in a responsiveness summary and incorporated as appropriate in the final cleanup action plan.

TABLES

TABLE 1. INDICATOR SUBSTANCE SCREENING - METHOD C COMMERCIAL SOILS

CONTAMINANT	Frequency of Detection	Maximum Concentration (mg/kg)	MTCA Cleanup Level, mg/kg	BASIS	SCREENING RESULTS
TPH					
TPH, TOTAL	0.68	51000	6000	ITPH	Indicator
Total Metals					
arsenic	0.53	24	20	Method A	Indicator
lead	0.02	1600	250	Method A	<=5% detection frequency
manganese	0.68	2900	44800	CNCAR	< cleanup level
LPAH					
acenaphthene	0	0	19200	CNCAR	< cleanup level
acenaphthylene	0	0			No toxicity data
anthracene	0.14	3.3	96000	CNCAR	< cleanup level
fluorene	0.21	25	12800	CNCAR	< cleanup level
naphthalene	0.36	52	70	100XGW	< cleanup level
phenanthrene	0.34	76	0		No toxicity data
HPAH					
benzo(a)anthracene	0.03	7.5	5.48	CCAR	<=5% detection frequency
benzo(a)pyrene	0	0	5.48	CCAR	< cleanup level
benzo(b)fluoranthene	0.05	0.15	5.48	CCAR	< cleanup level
benzo(ghi)perylene	0	0			No toxicity data
benzo(k)fluoranthene	0.02	0.0056	5.48	CCAR	< cleanup level
chrysene	0.02	9.8	5.48	CCAR	<=5% detection frequency
dibenzo(ah)anthracene	0	0	5.48	CCAR	<=5% detection frequency
fluoranthene	0.11	3.3	12800	CNCAR	≥ cleanup level
indeno(123-cd)pyrene	0	0	5.48	CCAR	< cleanup level
pyrene	0.21	33	9600	CNCAR	< cleanup level
VOC					
benzene	0.16	23	0.5	Method A	Indicator
ethylbenzene	0.2	55	20	Method A	Indicator
toluene	0.26	310	40	Method A	Indicator
xylene, total	0.4	1150	20	Method A	Indicator

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LPAH - Low-density PAH
 HPAH - High-density PAH

ITPH - Interim TPH Policy
 CCAR - C, carcinogen
 CNCAR - C, noncarcinogen
 100XGW - protection of ground water

TABLE 2. INDICATOR SUBSTANCE SCREENING - GROUND WATER

CONTAMINANT	Frequency of Detection	Maximum Concentration, ug/L	MTCA Cleanup Level, ug/L	BASIS	Screening Results
TPH*					
TPH-D	0.48	9,300			
TPH-G	0.48	8,000			
TPH-O	0.1	990			
TPH		18,290	1000	A, aesthetics	Indicator
Total Metals*					
arsenic	0.53	220	5	A	Indicator
lead	0.01	44	5	A	<= 5% detection frequency
manganese	0.68	2,600	50	MCL, aesthetics	Indicator
LPAH*					
acenaphthene	0.05	110	2100	BNCAR	< cleanup level
acenaphthylene	0	0			No toxicity data
anthracene	0	0	4800	BNCAR	< cleanup level
fluorene	0.15	250	640	BNCAR	< cleanup level
naphthalene	0.01	450	320	BNCAR	<= 5% detection frequency
phenanthrene	0.14	370			No toxicity data
HPAH*					
benzo(a)anthracene	0.01	9	0.012	BCAR	<= 5% detection frequency
benzo(a)pyrene	0.01	14	0.012	BCAR	<= 5% detection frequency
benzo(b)fluoranthene	0.01	11	0.012	BCAR	<= 5% detection frequency
benzo(ghi)perylene	0.01	17			No toxicity data
benzo(k)fluoranthene	0.01	11	0.012	BCAR	<= 5% detection frequency
chrysene	0.02	0.53	0.012	BCAR	<= 5% detection frequency
dibenzo(ah)anthracene	0.01	11	0.012	BCAR	<= 5% detection frequency
fluoranthene	0.01	32	370	NTR	< cleanup level
indeno(123-cd)pyrene	0.01	18	0.012	BCAR	<= 5% detection frequency
pyrene	0.03	31	480	BNCAR	< cleanup level
VOC*					
benzene	0.44	350	5	BCAR	Indicator
ethylbenzene	0.3	200	30	A	Indicator
toluene	0.22	990	40	A	Indicator
xylene, total	0.35	1,400	20	A	Indicator

LPAH-Low-density PAH
HPAH-High-density PAH

A - Method A
BCAR - B, carcinogen
BNCAR - B, noncarcinogen
MCL - Maximum Contaminant Level

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TABLE 3. RISK CALCULATION FOR SOILS - INTERIM TPH POLICY

Worksheet:																
Calculations for Using the TPH Interim Policy (Two Pathways: Human Health and Soil-to-Groundwater)*																
1. As in "Calculations for Using the TPH Interim Policy" example put the soil concentrations in the "Soil Conc" column.																
2. Examine the hazard index and risk for each land use you wish to use, for each chemical or fraction, and the "Conc. at the well."																
3. Hazard quotients for individual substances or fractions cannot exceed 1.0																
4. The hazard index (sum of the hazard quotients) cannot exceed 1.0																
5. The risk for individual substance or fractions cannot exceed 1×10^{-6} for residential land use or 1×10^{-5} for commercial or industrial.																
6. The risk for the total cannot exceed 1×10^{-5} for any land use.																
7. The "concentration at the well" cannot exceed 1.0 mg/L total TPH.																
8. If any exceedance occurs in 3-7 above, then the cleanup level for TPH has not been met.																
1	2	3	4	5		6		7		8		9	10	11	12	13
Compound	Soil Conc (mg/kg)	RfD (mg/kg*day)	OCPF (kg*day/mg)	Residential		Residential		Commercial		Commercial		MW	Moles	Mol. Frac.	Solubility	Conc.@ well
				Factor	Multiplier	HQ	Risk	Factor	Multiplier	HQ	Risk	(g/mol)	(mmol/kg)	(percent)	(mg/l)	(mg/l)
Aliphatics																
EC 5 - 6												81.0000			28.0000	1.0000
EC >6 - 8	50											100.0000	0.5000	0.0189	4.2000	0.0794
EC >8 - 10	50											130.0000	0.3846	0.0145	0.3300	0.0048
EC >10 - 12	25											160.0000	0.1563	0.0059	0.0260	0.0002
EC >12 - 16	25											200.0000	0.1250	0.0047	0.0006	0.0000
EC >16 - 21	200											270.0000	0.7407	0.0280	0.0000	0.0000
Total aliphatic	350	0.06		1.25E-05	2.08E-04	0.07		3.125E-06	5.21E-05	0.02						
Aromatics																
EC >8 - 10	15											120.0000	0.1250	0.0047	65.0000	0.3072
EC >10 - 12	50											130.0000	0.3846	0.0145	25.0000	0.3635
EC >12 - 16	85											150.0000	0.5667	0.0214	5.8000	0.1243
EC >16 - 21	500											190.0000	2.6316	0.0995	0.5100	0.0507
EC >21 - 35	5000											240.0000	20.8333	0.7877	0.0066	0.0052
Total aromatic	5650	0.03														
Benzene	0.005		0.029			1.45E-10				3.63E-11		78.0000	0.0001	0.0000	1780.0000	0.0043
c-PAHs	1		7.3			7.30E-06				1.83E-06						
Ethylbenzene	1	0.10		1.25E-05	1.25E-04	0.00		3.125E-06	3.13E-05	0.00						
Toluene	0.18	0.20		1.25E-05	6.25E-05	0.00		3.125E-06	1.56E-05	0.00		92.0000	0.0020	0.0001	520.0000	0.0385
Xylenes	1	2.00		1.25E-05	6.25E-06	0.00		3.125E-06	1.56E-06	0.00						
Total aromatic + B	5648	0.03		1.25E-05	4.17E-04	2.35		3.125E-06	1.04E-04	0.59						
Total						2.43	7.30E-06			0.61	1.83E-06		26.4498	1.0000		0.9780
*Note: This worksheet calculates Methods B and C soil cleanup levels for TPH for two pathways: "direct contact human health" and "soil-to-groundwater." Other possible pathways, such as vapor and surface water must be considered (see "Interim Policy"). In Addition to not exceeding a TPH level in the groundwater of 1.0 mg/L, there cannot be exceedance in the groundwater for individual substances such as the "BETX" compounds.																

TABLE 4. RISK AND HAZARD QUOTIENT CALCULATIONS - METHOD C COMMERCIAL SOILS

INDICATOR	ADJUSTED CLEANUP LEVEL, mg/Kg	FINAL CLEANUP LEVEL, Mg/Kg	BASIS	CANCER RISK	HAZARD QUOTIENT						
					H E M O T O X I C I T Y	H E P A T O T O X I C I T Y	N E P H R O T O X I C I T Y	N E U R O T O X I C I T Y	W E I G H T	M O R T A L I T Y	P H O I N S A C L P C R K H T E A A I A L T V S I A I E N S T D E E Y
Aliphatics											
EC 5-6											
EC >6-8	50	50									
EC >8-10	50	50									
EC >10-12	25	25									
EC >12-16	25	25									
EC>16-21	200	200									
Total aliphatic	350	350	ITPH		0.020	0.020	0.020	0.020	0.020	0.020	
Aromatics											
EC >8-10	15	15									
EC >10-12	50	50									
EC >12-16	85	85									
EC >16-21	500	500									
EC >21-35	5000	5000									
Total aromatic	5650	5650									
Benzene	0.005	0.005		3.63E-11							
c-PAHs	1	1		1.83E-06							
Ethylbenzene	1	1			0.000	0.000					
Toluene	0.18	0.18				0.000	0.000				
Xylenes	1	1						0.000	0.000		
Total aromatic: +B-E-X	5648.005	5648.005			0.590	0.590	0.590	0.590	0.590	0.590	
	Total soils cancer risk =				1.83E-06						
	Total soils hazard quotient =					0.610	0.610	0.610	0.610	0.610	0.000

TABLE 5. GROUND WATER CLEANUP LEVELS ADJUSTMENT/CANCER RISK AND HAZARD QUOTIENTS CALCULATIONS

[illegible]

LPAH - Low-density PAH
HPAH - High-density PAH

A - Method A
BCAR - B, carcinogen
BNCAR, - B, noncarcinogen
MCL - Maximum Contaminant Level

North Market Street DCAP

TABLE 6. TOTAL SITE RISK AND HAZARD QUOTIENT CALCULATIONS

MEDIUM	CANCER RISK	HAZARD QUOTIENT						
		H E M O T O X I C I T Y	H E P A T O T O X I C I T Y	N E P H R O T O X I C I T Y	N E U R O T O X I C I T Y	W E I G H T	M O R T A L I T Y	P H O I N S A C L P C R K H T E A A I A L T V S I A I E N S T D E E Y
Ground Water (from Table 5)	3.31E-06	0	0	0	0.0223	0	0	0
Soils (from Table 4)	1.83E-06	0.61	0.61	0.61	0.61	0.61	0.61	0.61
Total Site Cancer Risk =	5.14E-06							
Total Hazard Quotient =		0.610	0.610	0.610	0.632	0.610	0.610	0.610

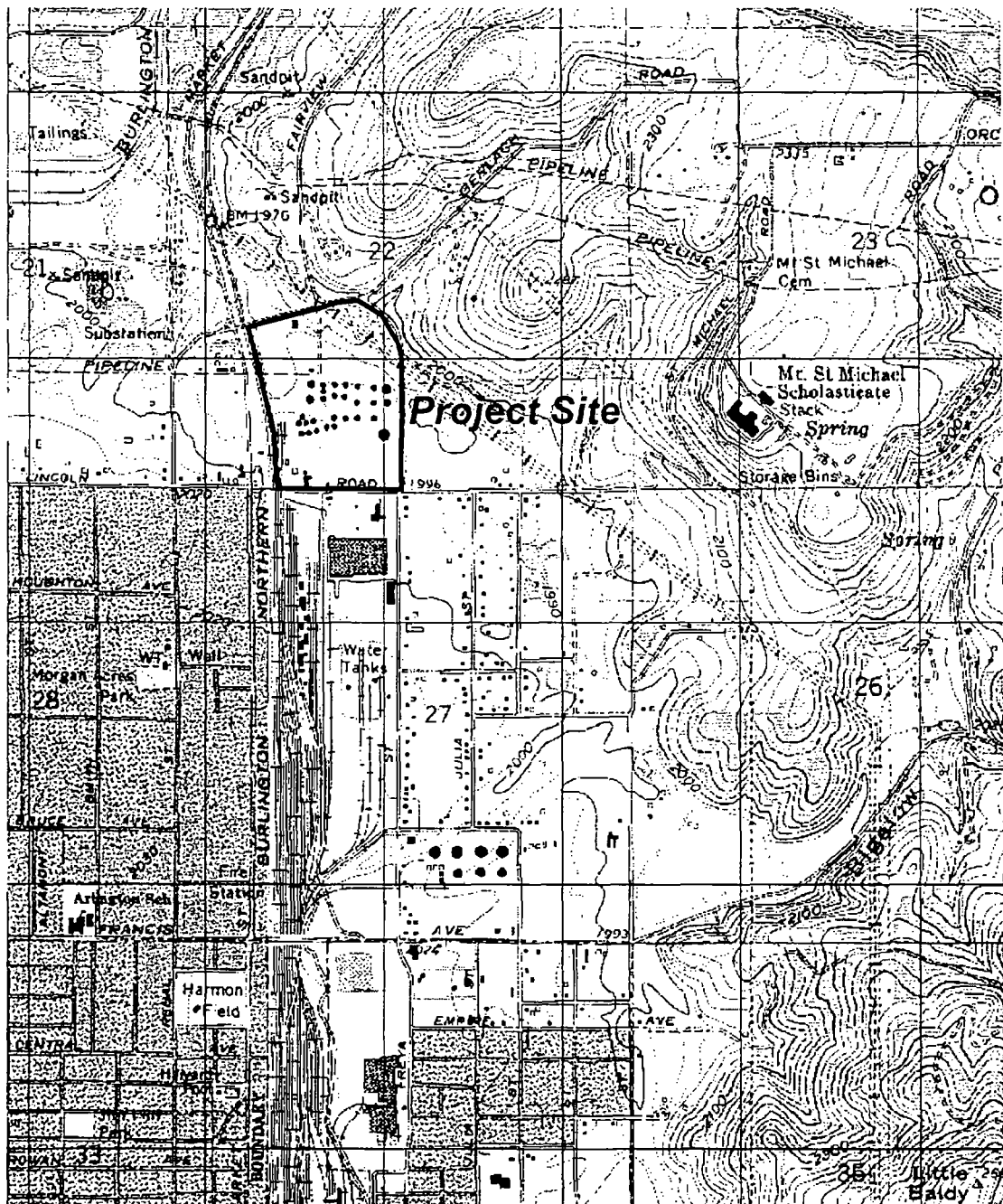
Table 7 - Risk Calculation for Potential Soil - Interim TPH Policy

Worksheet:																
Calculations for Using the TPH Interim Policy (Two Pathways: Human Health and Soil-to-Groundwater)*																
1. As in "Calculations for Using the TPH Interim Policy" example put the soil concentrations in the "Soil Conc" column.																
2. Examine the hazard index and risk for each land use you wish to use, for each chemical or fraction, and the "Conc. at the well."																
3. Hazard quotients for individual substances or fractions cannot exceed 1.0																
4. The hazard index (sum of the hazard quotients) cannot exceed 1.0																
5. The risk for individual substance or fractions cannot exceed 1x10E-06 for residential land use or 1x10E-05 for commercial or industrial.																
6. The risk for the total cannot exceed 1x10E-05 for any land use.																
7. The "concentration at the well" cannot exceed 1.0 mg/L total TPH.																
8. If any exceedance occurs in 3-7 above, then the cleanup level for TPH has not been met.																
1	2	3	4	5	6	7	8	7	8	3	4	11	6	12	8	13
	Soil Conc.	RfD	OCPF	Residential	Residential		Commercial	Commercial		MW	Moles	Mol. Frac.	Solubility	Effect. Sol.	DF	Conc.@ well
Compound	(mg/kg)	ng/kg*day	kg*day/mg	Factor	HQ	Risk	Factor	Multiplier	HQ	Risk	(g/mol)	mmol/kg	(percent)	(mg/l)	(mg/l)	(mg/l)
Aliphatics																
EC 5 - 6	5										81	0.1	0.01	28	0.1	0.144
EC >6 - 8	10										100	0.1	0.01	4.2	0.04	0.035
EC >8 - 10	15										130	0.1	0.01	0.33	0.003	0.0032
EC >10 - 12	10										160	0.1	0.01	0.026	0.0001	0.00014
EC >12 - 16	10										200	0.1	0.00	0.00059	0.00000	0.00000
EC >16 - 21	1750										270	6.5	0.54	0.000001	0.0000005	0.000001
Total aliphatic	1800	0.06		1.25E-05	0.38		3.125E-06	5.21E-05	0.09							
Aromatics																
EC >8 - 10	5										120	0.0	0.00	65	0.2	0.226
EC >10 - 12	5										130	0.0	0.00	25	0.1	0.080
EC >12 - 16	20										150	0.1	0.01	5.8	0.06	0.065
EC >16 - 21	20										190	0.1	0.01	0.51	0.004	0.0045
EC >21 - 35	1150										240	4.8	0.40	0.0066	0.00264	0.0026
Total aromatic	1200	0.03														
Benzene	0.002		0.029			5.80E-11			1.45E-11	78	0.0	0.00	1780	0.0	1	0.004
c-PAHs	1		7.3			7.30E-06			1.83E-06							
Ethylbenzene	1	0.10		1.25E-05	0.00		3.125E-06	3.13E-05	0.00							
Toluene	0.08	0.20		1.25E-05	0.00		3.125E-06	1.56E-05	0.00	92	0.0	0.00	520	0.0	1	0.038
Xylenes	1	2.00		1.25E-05	0.00		3.125E-06	1.56E-06	0.00							
Total aromatic + B-E-X	1198	0.03		1.25E-05	0.50		3.125E-06	1.04E-04	0.12							
Total					0.87	7.30E-06			0.22	1.83E-06		12.0	1.00			0.6
*Note: This worksheet calculates Methods B and C soil cleanup levels for TPH for two pathways: "direct contact human health" and "soil-to-groundwater." Other possible pathways, such as vapor and surface water must be considered (see "Interim Policy"). In Addition to not exceeding a TPH level in the groundwater of 1.0 mg/L, there cannot be exceedance in the groundwater for individual substances such as the "BETX" compounds.																

TABLE 8 - Applicable or Relevant and Appropriate Requirements (ARARs)

ACTION	REFERENCE	COMMENT
Cleanup Construction	29 CFR 1910	Occupational Safety and Health Act
	Ch. 296-155 WAC	Safety Standards for Construction Work
	Ch.296-62 WAC	Occupational Health Standards - Standards for
		Carcinogens, Part P Hazardous Waste Operations and
		Emergency Response
Cleanup Standards	Ch. 43.21 RCW;	State Environmental Policy Act and Rules
	Ch. 197-11 WAC	
	Ch. 173-340 WAC	Model Toxics Control Act
	Ch. 173-160	Minimum Standards for Construction of Wells
	42 USC 300	Safe Drinking Water Act
	Ch. 173-340 WAC	Model Toxics Control Act
	SCAPCA Regulation 1	Control of Fugitive Emissions

FIGURES



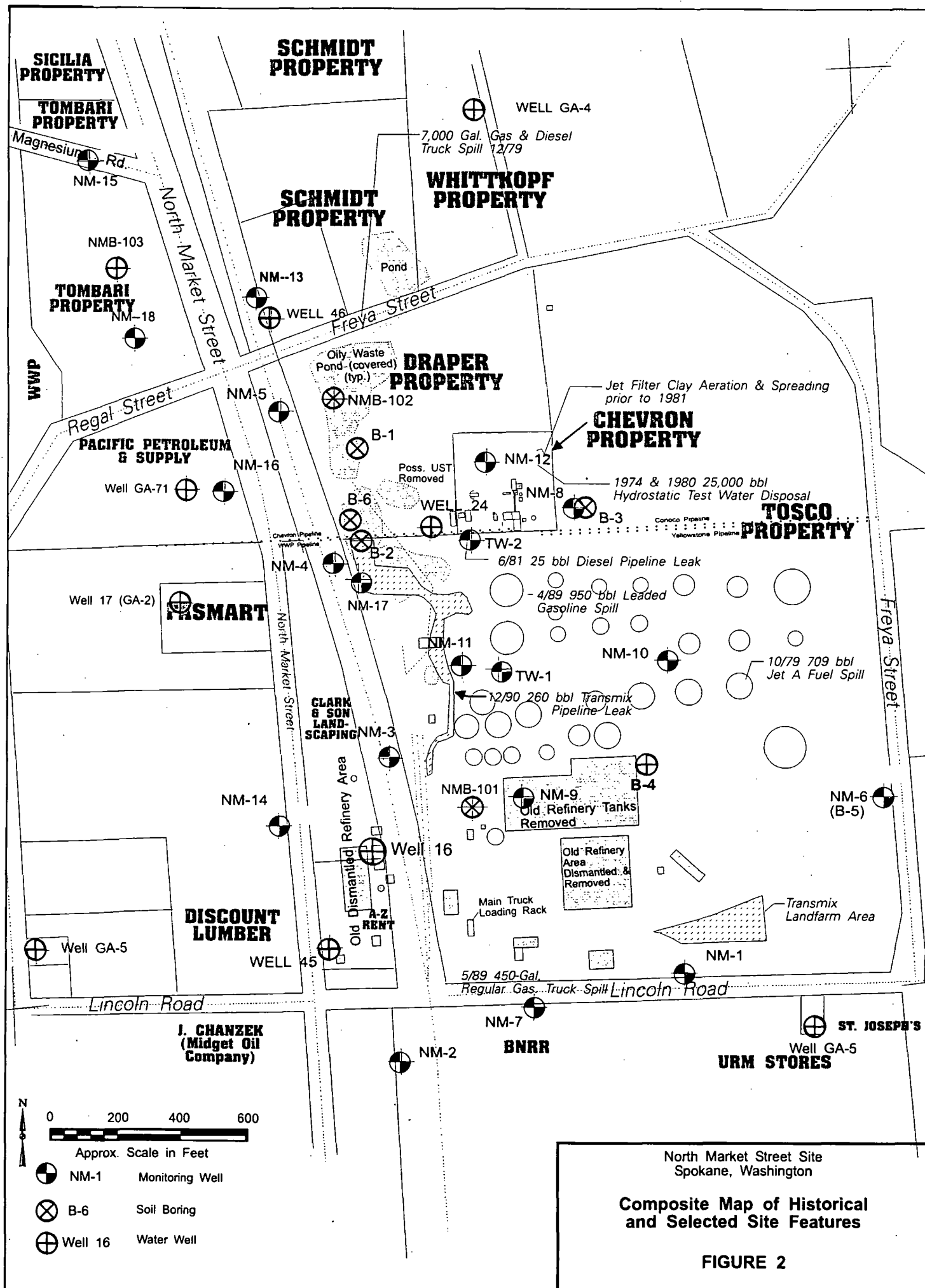
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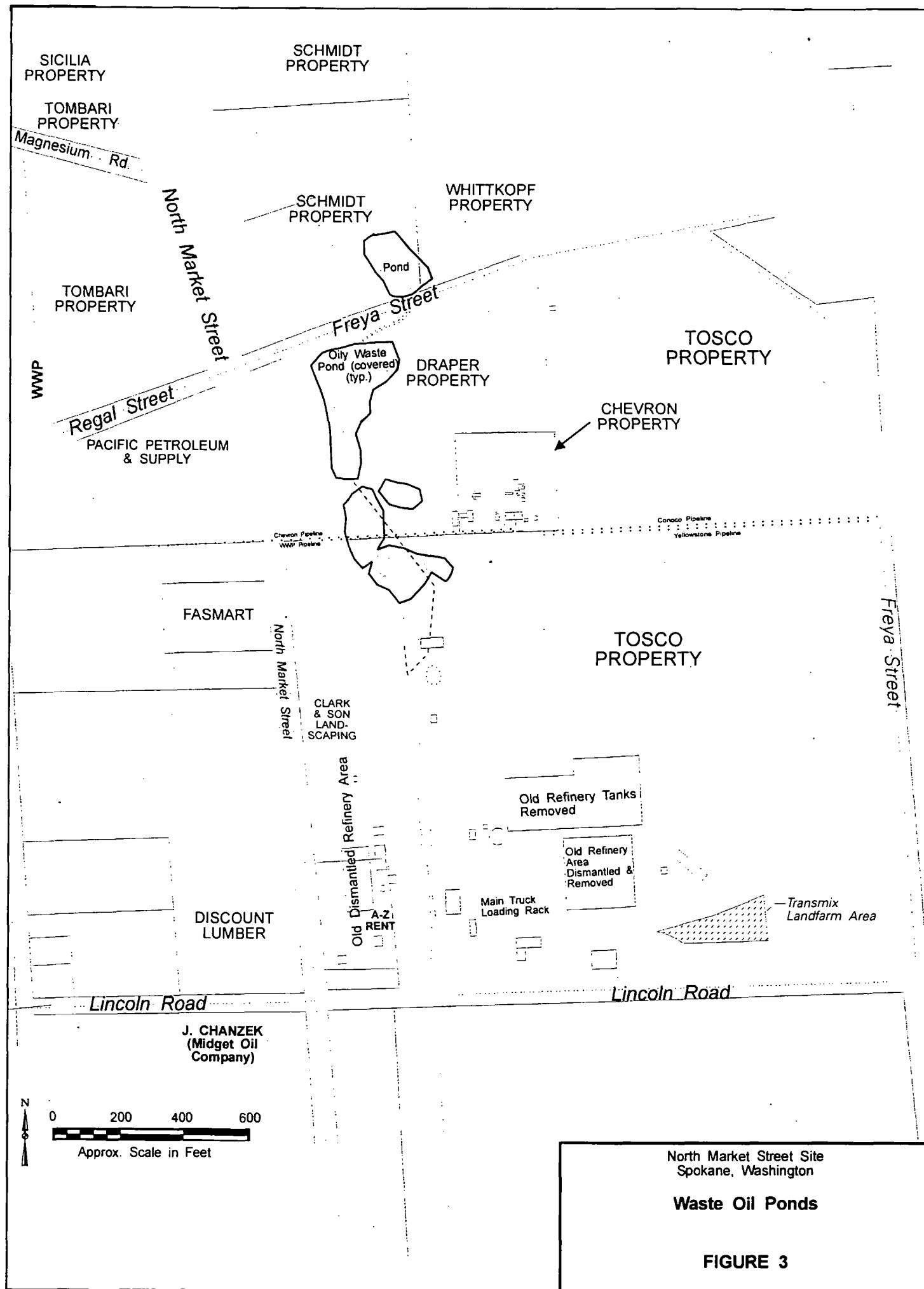
Source: U.S. Geological Survey
7.5 Minute Series Map
Spokane Northeast Quadrangle
1973 Photorevised in 1986

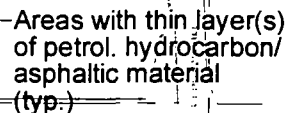
North Market Street Site
Spokane, Washington

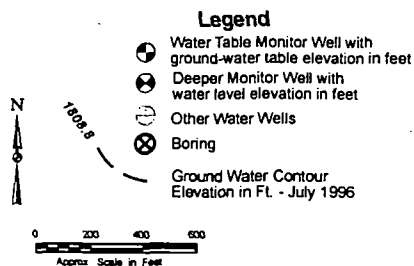
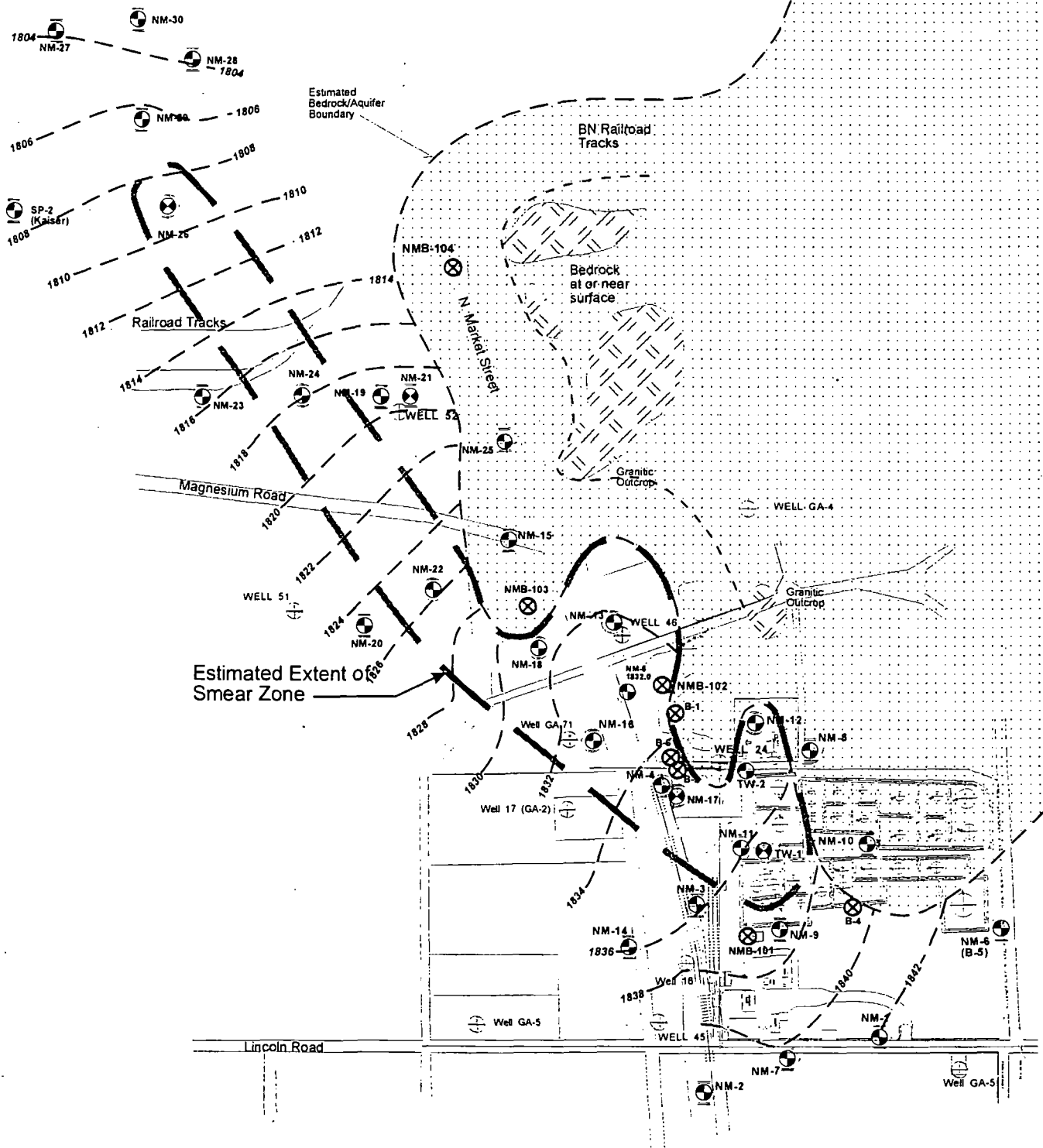
Vicinity Map

FIGURE 1





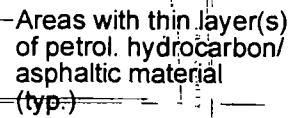


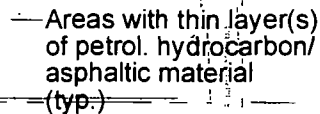


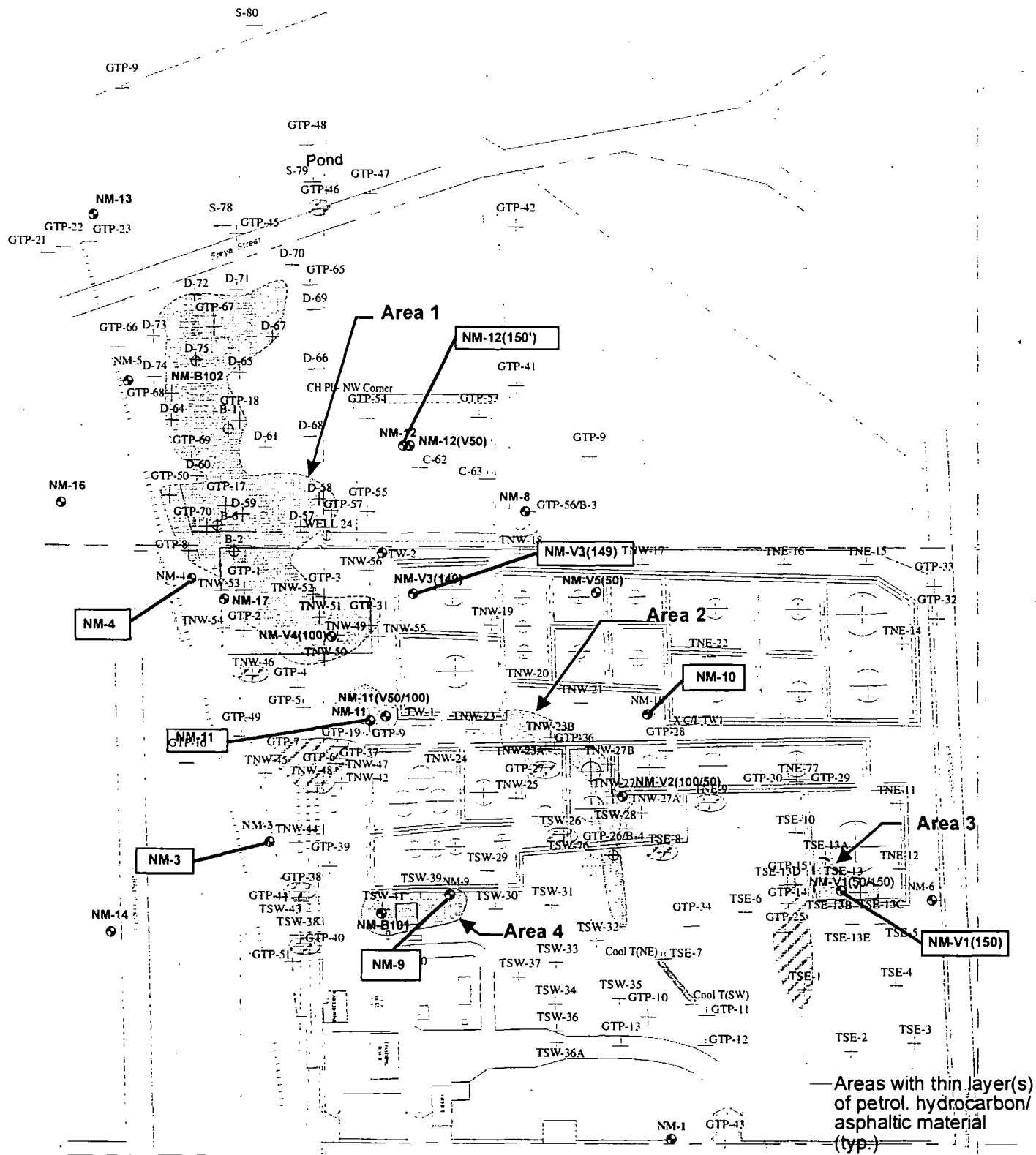
North Market Street Site
Spokane, Washington

**Estimated Smear Zone
and Well Locations**

FIGURE 5







North Market Street Site
Spokane, Washington

**Soil Vapor Sampling Locations
Near Water Table**

FIGURE 8

